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THE ACTION OF COMPOUND DYNAMOS WHEN RUN IN PARALLEL.

ALTHOUGH it is now a good many years since the coupling of two compound dynamos in parallel was first effected, it is comparatively seldom that one sees any important installation in England where such dynamos are regularly so run, but in America the practice is much more common, and the difficulties of evenly dividing the load amongst the several machines have therefore attracted more attention. This difference in practice is due, no doubt, to the fact that in England there are but few important power stations, and in central lighting stations where the pressure must be maintained constant at the feeding centres but little advantage can be gained by the use of compound or over-compounded machines, because hand regulation cannot be dispensed with for the feeders, and the switching on of an extra machine to meet an increased demand for current has the effect, not of increasing the pressure at the switchboard in proportion with the total output, but of lowering it, owing to the fact that each individual dynamo is giving a smaller current.

In power stations for tramway work when small variations of pressure are of slight importance, but the big fluctuations due to the rapidly changing load when cars are stopped and started must be avoided as much as possible, the compound machine offers considerable advantages over the simple shunt, and it is therefore employed in most traction stations in America. That its use has not been free from trouble we learn from a paper by Mr. William Puffer, bearing the title we have adopted for this article, as in introducing his subject he says that at all the power plants he visited, he found "a very common knowledge of the trouble in making the dynamos work well together, but there seemed to be no attempt to help the matter, or, as far as I could find, any knowledge of where the fault was."

It appears from this paper that the common practice of the American dynamo maker is to over-compound all machines, and afterwards, when the conditions under which any particular machine will work are known, to adjust the series ampère-turns by shunting the series winding by means of a German silver strip or wire, and it is the use of machines of this type that is the cause of the trouble in the traction stations. The author of the paper discusses the conditions which must exist if two machines are to work well in parallel, and shows, by means of diagrams, that unless the external characteristics of the dynamos are the same, the load cannot be equally divided at all outputs. For example, if through any cause, such as structural difference in the machines, the characteristic of a shunt dynamo, A, is steeper than that of another, B, that is if the drop in terminal volts between open circuit and full load is greater for A than for B, and if the dynamos are running at any given output with the load equally divided, then B will supply more than its share of

current if this output is increased, and less than its share if the joint output is diminished.

If hand regulation is employed, this unequal division of the load need be only momentary, as the regulating resistances can be so adjusted as to equalise the two outputs; but if, to avoid hand regulation, compound dynamos are used, then it becomes absolutely necessary that the characteristics of the machines shall be the same if they are to work well together. The practice of adjusting the compounding mentioned above, though very convenient for machines running singly is, of course, useless, when two such machines are coupled in parallel, as the two sets of series coils and their adjusting shunts being all in parallel the shunts no longer have any separate regulating effect on the coils to which they are connected, and the division of the load will therefore depend on the characteristics of the dynamos with their series winding unshunted. The remedy is simple, but it does not appear to have occurred to any manufacturer or station engineer until suggested by Mr. Puffer; it consists in adjusting the series ampère turns of machines meant to run in parallel, by putting the adjusting resistance in series with the winding instead of as a shunt, or as an alternative, which does not appear to us so good a plan, by putting a resistance in series with the armature circuit of any dynamo which takes more than its share of the load. The author of the paper found that machines so adjusted would run together perfectly, and that there was no change of voltage nor any difficulty in switching in and out machines, if these were compounded for constant pressure at their terminals; but on the other hand, he found that if machines were compounded for constant pressure at a distant point, the switching in or out of machines was not so easy. The result of a series of experiments showed that if the new dynamo was brought up to the same voltage and then switched in, the voltage did not change much, but the shock to the armatures was considerable, and it was possible for the new dynamo to take all the load and even to drive as a motor the machine which was already running. On the other hand if, to avoid shock to the armatures, the new machine was switched in when at a lower voltage, then the joint voltage was considerably lower than that of the single machine already running. It would appear that the only way of arranging over-compounded machines so that they will run well together without the addition of hand regulation, is to permanently connect in the circuit all the series windings, in which case the pressure at the bus bars will rise and fall with the total load, and the individual machines can be considered as simple shunt machines, and can be switched in and out without any further precautions than those ordinarily observed for such machines, since the series windings practically form a part of the external circuit.

The paper concludes with an example of the magnitude of the effects due to a difference in series exciting power, and although the case is a very exaggerated one, it is nevertheless interesting. Two machines giving 220 volts and 45 ampères normal output, and having similar characteristics when run as shunt machines, were taken, and to the series winding of one were added a few turns of wire, whilst a resistance was added to the series winding of the other, so as to make the resistances of the windings on both machines equal. Run separately, so as to be compounded for 220 volts, it was found that about 9 and 18 ampères respectively had to be shunted past the series windings, leaving 36 and 27 ampères respectively to produce the necessary ampère turns for compounding. Run in parallel at the same speed, and with a joint output of 90 ampères, the current from each dynamo was respectively 26 and 64 ampères, a division of the load which, if continued for any period, might have disastrous effects on the machine taking the lion's share.

GAS POWER FOR CENTRAL STATIONS.

WE commented last week on the use of gas plant for small power purposes, and suggested one or two possible economies in its use. Our object now is to consider the more ambitious employment of gas power for practical central station work. Up to the present there has been more or less uncertainty as to the actual capabilities of gas engines, compared with steam, when used for moderate sized stations. It was well known that there were many advantages, but those advantages were rarely reduced to plain matter of fact figures. The saving of space alone would warrant gas plant being allowed to have a little less efficiency; then the ease of manipulation and little attention required were obvious. We do not for one moment wish to suggest that gas plant has been proved to have less efficiency than steam plant; we think, rather, that, as far as our information goes, it has shown the reverse. However, the advantages of gas compared with steam have been set forth time after time; but, presumably, they have not been sufficient for central station engineers. They have, apparently, waited for what they considered reliable tests before committing themselves to such radical changes as the adoption of the gas engine would involve. An American contemporary has recently published some valuable tests taken over a prolonged period of two years. They are important because they entirely corroborate the results obtained in England and on the Continent, results, by the way, which have been received with scepticism by many engineers in this country. The case under notice was that of an isolated plant, in which the dynamos were driven by engines using town gas. The cost of gas per 1,000 cubic feet was 2s. 10d., the works' cost per unit was 1·2d., while the total cost, including attendance, interest on capital expended, and depreciation, did not exceed 3d. per unit. This is a good sample of economical running; for it must be remembered that this is a small isolated plant, dependent on the town mains for its gas supply. Although this instance would compare favourably with the lowest works' cost of the largest central station, it would not be fair to the performance of the gas plant. For it is well established that no large central station designed to use gas plant would do otherwise than manufacture its own gas, and it would be, we imagine, a poor producer which could not turn out gas at a less cost than 7d. per 1,000 feet. On this basis we might make some astonishing calculations by a simple arithmetical process, which would bring the cost of a unit to an absurdly small figure, though there would be extra depreciation and attendance on the gas plant to add to this. Such calculations, however, would scarcely serve a useful purpose. We might, however, at this stage refer to an article which is published in another column on the subject of producer gas engines. It will be seen from this that there will be a constantly recurring improvement in the pro-

ducing gas apparatus, though we can scarcely say that this under question will have more efficiency than that obtained when using Mr. Dowson's system. The most noted example of a gas electric station doing practical town lighting is that at Dessau, in the Duchy of Anhalt. From figures which have been recently published, it is apparent that the cost per kilowatt when using town gas is 1·17d. This is lower than the foregoing example, but it must be pointed out that much larger engines are used at Dessau. It soon becomes apparent, when gas plant is installed, that there is great improvement in economical running; that is to say, quite a little experience of gas plant is sufficient to enable the designers to effect improvements. For instance, at Dessau, they originally commenced to run with gas engines, driving dynamos by belting; they have now practically abandoned that method, and have substituted larger engines, coupled direct to the dynamo. The largest engine, we believe, used at this station, is 120 effective horse-power; so it may be at once seen that this is a fairly good specimen of a small central station. In justice to German makers we ought not to omit to mention that they have made many improvements in combined gas engines and dynamos. They have adapted both dynamo and engine to each other in such a manner that they are enabled to reduce considerably the quantity of gas per horse-power hour. We do not mention this in order to depreciate the work of English gas engine makers, for we have absolute confidence in these makers meeting every demand that is made upon them; they suffer in comparison with the Germans simply for lack of opportunity. It is plainly evident from the Dessau figures, as well as from others, that the small stations using steam are hopelessly left behind as regards cost of running. It is notorious that small steam stations are more wasteful than useful; and it is only with small stations that we ought to compare Dessau, although as we have pointed out there would be little to fear in comparison with the best steam plant. An instance nearer home of a gas station is the one at Morecambe, which supplies part of the town with electricity. Originally town gas was used, which being expensive, brought the cost per unit to a little over 2d. Since, however, Dowson producing plant was used, the cost per unit has been reduced to ½d. Instances such as this might be multiplied, but enough has been said to show the inexpensive working of gas stations generally.

In theory, no doubt, the adoption of gas sub-stations for purposes of lighting an area is about the best; whether it would be borne out in practice has yet to be proved. In crowded places, like the City of London, where land is valuable, there might be some difficulty in the way of underground stations containing machinery in motion. We do not wish to conjure up phantom difficulties which may not exist in actual practice; but at the present moment we have no case of a sub-station from which we may draw reliable deductions. It is safe to assume, however, that the difficulties in the way of sub-stations will be, for the most part, less than those that have been encountered in existing central stations, for the problem of getting near to the consumers is solved in a practical manner. It would be more practicable to have gas-producing apparatus outside the area of supply, and sending gas to the sub-stations through pipes, than it is to have high tension stations transmitting electricity to sub-stations. There is surely no question of the cheapness of gas used in this manner. In this respect the letter of Mr. Brown, which was published in our last issue deserves some notice. He draws attention to the fact that coke in Edinburgh is exceedingly cheap, being, in fact, about 4s. per ton. It is of little use for household purposes, but it would be quite good enough for gas-producing purposes. This gas could be sold at 2d. per thousand feet at central electric stations; and, what is more, the gas mains would run through crowded streets, which would create a demand for the gas for cooking purposes. We cannot make ourselves responsible for Mr. Brown's low estimate, but certainly the matter should appeal to the pockets of the gas companies.

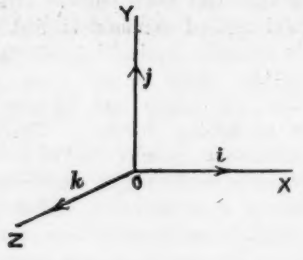
What might be done with considerable success in London suburbs—or any suburbs, for the matter of that—is the erection of plant which would supply small areas, say, with a a frontage of about a thousand yards. There would probably be in this area, say, twelve or fourteen good-sized houses willing to take a supply of electricity. About the centre of these houses a building might be erected not more imposing than an iron one. In this could be placed twelve gas engines driving twelve dynamos, the policy being to have a separate dynamo and engine for each house. A gas engine would then only need starting when the house indicated by telephone message that light was required. This would not be such a wasteful method as might at first appear, because light would be generally required between stated and regular hours, unless the family in one house were away, in which case the gas engine and dynamo would remain idle without consuming anything. During the hours of least demand—say, from midnight to dawn—one gas engine and dynamo could supply the whole of the houses. The point, however, which we wish to urge is, that the gas company should erect the gas engines at their own cost, and which would remain the property of the gas company. Then the tenants of the twelve houses might combine for the purpose of erecting the purely electrical part of the work, the gas company could supply a man or two for the purpose of keeping the station, and would charge accordingly. The result would be, that the consumers would get their electricity at about the same price as they would obtain gas, with the addition of interest on capital laid out in dynamo and mains, and the wages of the men in charge. This would add very little, however, to the cost of a unit, for it must be pointed out that the mains would be comparatively cheap, because the station being at the back of the houses, cost of trenches would be small. To carry out this arrangement most successfully, it would be necessary to avoid crossing the road, so that there would be no risk of coming into collision with the local authority or any other suppliers of light. Under these conditions no provisional order would be necessary, for it is open to any person to become a supplier of electricity. There might, of course, be many difficulties in the way of such a co-operative arrangement, but if the gas company were to become responsible for the engines there would be persons ready enough to take the responsibility of supplying dynamos and keeping the plant running. Many improvements on what we have thrown out would no doubt suggest themselves in the way of using accumulators, and so forth. Gas engines might be let out on hire by the gas company much in the same way as they let out stoves on nominal terms. However, the gas companies are mostly affected, and it is to their advantage to consider the methods of keeping up their sale of gas; if they can do so by promoting electric lighting they will do themselves and the public great benefit. In this respect we might mention the attitude of the Continental gas companies. It was the German Continental Gas Company which established the Dessau electric light station previously mentioned, and so successful do they consider the venture that they are about to erect electric light stations with gas engines in other towns in which they have the monopoly of gas supply.

It is obvious that the scheme sketched out would be totally inapplicable to a crowded neighbourhood, or in the centre of a town; there, of course, is the province of the gas engine sub-station. But such an arrangement might be carried out over and over again in the suburbs of London.

RELATIONS BETWEEN CURRENT, MAGNETIC INDUCTION, AND MOTION.

BY E. C. RIMINGTON.

THERE are now a large number of "memoria technica" for finding the direction of the induced E.M.F. or current in a conductor moved so as to cut the lines of magnetic induction, or for the converse case of determining the direction of motion of a conductor carrying a current when placed in a magnetic field. They are, most of them, rules with reference to the position of the hand or fingers. I, for one, must confess that I always forget the rule when wanted; either one forgets how to hold the fingers, or, if this is remembered, what the different fingers mean. There is one which

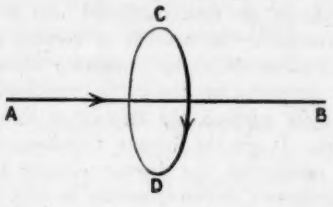


happened to make an impression on my memory, and that is the axes used in vectors O X, O Y, and O Z (O Z is towards the reader), the unit vectors being i, j, and k, along these axes respectively. Then i stands for induction, k for current (spelt kurrent), and j for jump, or the direction of motion. To those unfamiliar with vector terminology this rule would be less likely to be remembered than one connected with the hand or fingers.

It seems better to be able to quickly reason out the matter than to have to depend on artificial aids to the memory, and it is a simple matter to do this from fundamental principles, as I hope to be able to make clear in what follows.

As the direction of current in a conductor, and also that of magnetic induction, are both arbitrary, there must be an arbitrary relation between them when they have been defined. This relation is a very simple one, being that of a right-handed screw, with which everyone is familiar, and it is consequently a very easy one to remember.

In the case of a straight conductor, A B, carrying a current, the direction of the current is that of the thrust of the screw when turned, and the direction of the magnetic induction is the direction in which the screw is turned,* this is shown in the figure; A B represents the current, and the circle C D the direction of the magnetic induction. Again the direction of turning the screw may represent the direction of the current round a closed circuit, in which case the direction of motion of the screw will represent the direction in which the

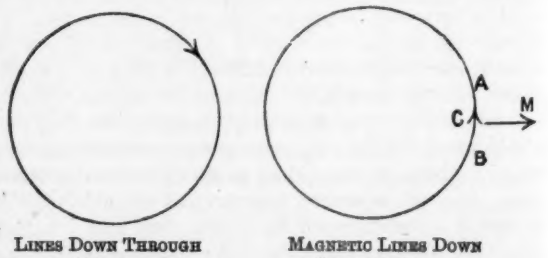


magnetic induction threads through the circuit. Thus C D represents a current in a coil, then A B represents the direction of the induction threading that circuit. I always consider this a much simpler method of finding the relation between current and direction of magnetic lines, than Ampère's well-known rule of imagining one'sself swimming with the current and looking at a magnetic needle when its north pole will be deflected towards one's left hand.

Suppose, then, we have a circle carrying a current in the direction of the arrow, or clockwise, the lines of induction are directed down through the paper. Imagine now the current to increase, this will mean the number of lines threading the circuit also to increase, and it is known that an increase in the lines means an E.M.F. acting in the circuit. What will be the direction of this E.M.F.? Obviously the reverse way round the circuit to the current or counter clockwise. Why? Suppose it acted in the same direction as the current, this would mean a more rapidly increasing current, a more rapid increase of lines, and this a higher E.M.F., and so on until we finally arrived at an infinite current; this would, of course, be absurd and contrary to Ohm's law, because it would enable a finite E.M.F. to generate an infinite current in a circuit of finite resistance. Consequently the E.M.F. due to increasing the lines through a circuit must act in the contrary direction round a circuit to that of a current that would cause these lines. It is very easy to remember then that the E.M.F., acting in a circuit, due to an increase of magnetic induction through it, is related to the direction of the magnetic induction just the reverse way to a right handed screw, that is in the way of a left handed screw. If we prefer it, we may say that the relation is that of a right handed screw when the lines are diminishing.

Suppose, now, we take a circle and place it in a magnetic field whose direction is down through the paper. Imagine it to expand; this means that the lines through it are increasing, and the E.M.F. or current induced in it will be counter-clockwise, or in the direction of the arrow head, C. If we take a small portion of it, A B, we may consider it as a straight conductor moving in the direction of the arrow, M, and cutting the lines which are downwards through the paper, the induced E.M.F. or current in it is from B to A.

Now to consider the converse case, that is the direction of motion in a magnetic field of a conductor carrying a current and due to the current. The conductor in moving may be made to do work, and this work must come from the current; now, the only way in which a current can do work other than dissipating heat energy in the conductor in which it flows, is by encountering an opposing E.M.F. Hence the E.M.F. induced in the conductor by its motion in the magnetic field must oppose the current producing that motion, but, if the direction of motion is represented by the arrow head, M, the direction of the E.M.F. due to the motion we have have just seen is B A, hence the current producing the motion must have been from A to B. That is to say if the



LINES DOWN THROUGH PAPER. MAGNETIC LINES DOWN THROUGH PAPER.

direction of the current in a circuit and that of the magnetic field are the relations of rotation and thrust in a right-handed screw, the circuit will tend to expand outwards. By considering a small portion, such as B A of the circuit, we obtain the relation between current and motion in the case of a straight conductor, that is the magnetic induction away from one through the paper and the current downwards, the motion will be to the right. The above may seem difficult to remember, but if thoroughly understood it is really very easy to think it quickly out, or the rule "right-handed screw relation of current and induction means expansion" may be remembered, and is I think easier to recollect than aids to memory about holding the fingers or hands in particular positions.

* It is most easy to think of screwing a corkscrew into a bottle, you turn the handle clockwise and the screw goes away from you.

When the current is caused by the motion instead of causing it, all that need be remembered is that something must be reversed so that "right-handed screw relation of current and induction is caused by contraction," or "expansion causes left-handed screw relation of current and induction."

WILKENS'S IMPROVED AUTOMATIC MECHANICAL CUT-OUT.

THE advantages of the electro-magnetic cut-out over the ordinary lead or tin wire fuse should be much more generally appreciated by electrical engineers. Those who have thought about the matter naturally prefer the automatic cut-out, but fuse wires seem cheap at first sight, and it is the custom to use them. Automatic cut-outs are thus thoughtlessly treated with undeserved neglect. One reason is, of course, the higher first cost and the greater complication, many people objecting to the use of mechanism where it can be avoided.

As to the price, however, it will be found in looking into the matter that the magnetic cut-out can really compete favourably with the fuse box in cases where the fuse goes frequently, for then it is necessary to replace the fuses often, and this means a continual expense, which, if capitalised at the lowest rate of interest, comes to much more than the extra cost of the magnetic cut-out.

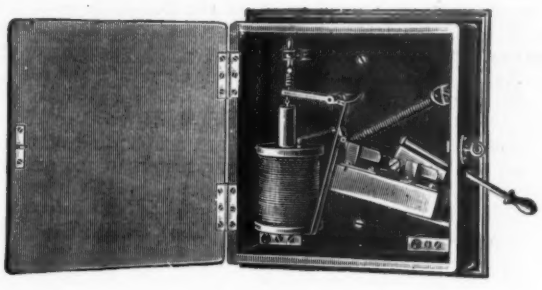
The fuse wire has also several other serious disadvantages. Each circuit needs its own fuse suitable for its maximum current. The result is that a number of spare fuses must be kept at hand. It generally happens that there are none on the premises, so that if a fuse goes, part or the whole of the premises is left in darkness for the night, or ought to be, although it is extremely probable, under such circumstances, that a piece of heavy copper wire is called upon to take the place of the fuse, as the temptation to secure a light again is overpowering, as well as not being troubled with the melting of the fuse again. There is also constant annoyance due to wrong fuses being put into circuit by stupid servants. The automatic cut-out has none of these drawbacks. It is set once for all to go at a certain current, and it goes at that current. It is locked up so that it cannot be interfered with by servants, and there is neither delay nor expense in making the circuit again after removing the cause of the accidental "short," or whatever has given rise to the excessive current.

Automatic cut-outs for interior use have been designed by Goolden & Trotter, Killingworth Hedges, the Interior Conduit and Insulation Company, and others, and some of the forms have features of novelty and ingenuity. One of the most generally used patterns is the well-known Cunynghame cut-out, which won such warm encomiums from Sir David Salomons, while the Prentice device, which has the same end in view, has been described in these columns. The great objection to the two latter English designs is the presence of mercury, which is apt to give trouble, and, in case of sparking, to give rise to a serious arc.

The points, to use a sporting phrase, of a good magnetic cut-out are, first, the apparatus must be absolutely certain in its working, either with an instantaneous increase of current or a gradual rise above the permissible maximum. Secondly, the householder, or consumer, must be able to replace the cut-out without delay and without having to search or send out for something. Thirdly, the apparatus must be under lock and key, so as to be out of reach of unauthorised persons, but it must be accessible for re-making the circuit.

The apparatus illustrated was specially designed to fulfil these requirements. It is a double automatic cut-out, and consists essentially of an ampèremeter, a double switch and detaching gear. The ampèremeter is of the solenoidal form, with a laminated soft iron core, so that it is equally applicable to alternating or direct currents. The pull of the core is opposed by a spring, which is regulated by a screw, so that the cut-out can be set for different currents. The core is attached to the lever, carrying a small tooth which holds the catch spring, this in its turn holding the main switch. The sensitive ammeter is thus not burdened by having to work a heavy switch directly. If the current exceeds the normal, the ammeter releases a comparatively small spring. The effect of this is to release the main switch, which springs open suddenly and breaks the circuit with little sparking. The circuit can be completed again by working the small lever which passes through the case. Unless the cause of the excessive current has been first removed, however, the switch will not preserve the contact.

As a proof of the action of such a cut-out, it may be mentioned that the instrument has been carefully tested at the



Electro-technical Laboratory at Munich, the report concluding in the following words :—"It can, therefore, be stated definitely that the cut-out works with regularity and accuracy. The maximum current with the adjustment, as made, was 7·3 ampères cold and 7·2 hot. The variation point of cutting out is never more than 0·06 ampère. No case of failure of action was observed."

As an example of design, the instrument seems to possess the merit of being correct in principle, for all such apparatus should only employ the current to act as a "brain" upon controlling apparatus, the switching off or power portion of the mechanism corresponding to the "muscle" being obtained by auxiliary means, such as springs, weights, and so on.

The instrument from which our illustration has been taken is one manufactured by Messrs. Hartmann and Braun, and is in very general use on the Continent, although we are not aware that it is known in this country.

PUPIN'S RESEARCHES ON ELECTRICAL OSCILLATIONS.

(SECOND NOTICE.)

A VERY faithful mechanical picture of the periodically varying flow in an electrical circuit possessing *localised* * capacity and self-induction is obtained by considering the motion of a torsional pendulum, that is, a heavy bar, say of cylindrical form, suspended on a stiff elastic wire. The moment of inertia of the bar and the elasticity of the suspension wire correspond to the coefficient of self-induction and the capacity of the circuit. The frictional resistance of the air corresponds to the ohmic resistance, and the internal friction in the bar and the elastic suspension correspond to magnetic and dielectric hysteresis; angular displacement of the torsional pendulum corresponds to the electrical charge of the condenser, and therefore torsional reaction of the suspension to difference of potential between the condenser plates. Angular velocity in the one case stands for the current, in the other kinetic energy for electro-kinetic energy, potential energy of the torsional forces stands for the electrostatic energy of the condenser charge.

In slow mechanical vibrations, the decrement of the kinetic energy is chiefly due to external and internal frictional resistances. But as the frequency of the vibration increases, other losses causing this decrement become more prominent, so do the losses due to radiation in the form of sound waves. Similarly, in electrical oscillations of very high frequency, the decrement of the electro-kinetic energy due to radiation in the form of electro-magnetic waves becomes considerably larger than that due to dissipation in consequence of ohmic

* The term *localised* is employed to distinguish the circuits considered in this paper from those electrical circuits in which self-induction and capacity are more or less uniformly distributed over the whole circuit, as, for instance, in the case of a Hertz resonator.

resistance, magnetic and dielectric hysteresis. The analogy, therefore, supplied by mechanical vibrations, is by no means a bad guide in the study of even very rapid electrical oscillations. For slow vibrations the analogy is very striking and instructive.

Dr. Pupin discusses some rather familiar mechanical problems in their mathematical bearing, and shows that they may be made to throw a strong light upon electrical problems. He then proceeds to an analysis. The problems considered in the present paper are the following:—

1. The natural period of an electrical circuit possessing localised capacity and self-induction.
2. The electrical flow in a resonant circuit.
3. Electrical resonance in a circuit with a complex harmonic electromotive force.

The analyses of these problems are not capable of useful condensation, and we must refer our readers to the original paper in the *American Journal of Science*, Vol. xlv., Series 3, No. 269, pages 420—429. Pupin proposes, in a subsequent paper, to study the resonance in electrical systems consisting of a primary and a secondary circuit with localised self-induction and capacity, and to describe several experiments bearing upon the theory of low frequency resonance.

GRANGER'S DUPLEX STEAM JET NOZZLES FOR FORCED DRAUGHT.

IN the case of steam boilers where the natural draught is weak or sluggish, great practical and also economical advantages are obtained by the adoption of some form of artificial or forced draught, in which the blast is produced either by means of a fan or by the use of steam jets. The fan systems are well known and effective, but involve a considerable expense and more or less complication. The use of steam jets is also a well-known device, and for simplicity and very low first cost and maintenance leaves nothing to be desired; but there is an impression among engineers that they consume a good deal of steam. This is, to some extent, correct, because no attempt has hitherto been made to improve the efficiency of jets, or to investigate the principles

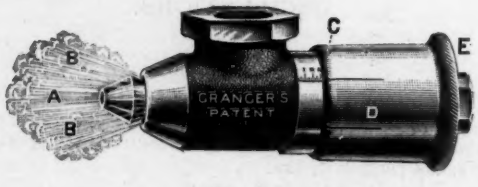


FIG. 1.

which govern their action, and consequently the common steam jet has remained in the same crude condition as when first used, 50 or 60 years ago. Recently, however, numerous experiments with steam jets have been carried out and a new type of jet has been designed, based upon the results obtained from these experiments.

In the accompanying illustrations, fig. 1 shows Granger's patent duplex steam jet nozzle, in which the plain or solid jet, A, is supplemented or assisted by the annular jet, B, B, the combined action of the two being more effective than either one used alone—area for area. The annular jet can be readily adjusted in area by turning the milled hand rim, E; the graduations, C and D, serving to facilitate and define the adjustment. It is of the utmost importance that the area, and consequently the force or effort, of a steam jet should be easily adjustable so that it may work effectively with various and varying steam pressures and also give more or less blast, as may be required from time to time according to the condition of the fire, &c. When working with low steam pressures, as for instance when getting up steam, the nozzle has to be opened so as to increase the area of the jet, while with higher pressures less steam suffices and the nozzle should be closed up in proportion. Hitherto it has been customary to merely throttle the supply of steam to a jet by means of a stop-valve, but this operation effectually robs the jet of its vigour and force of impact upon which its action so much depends.

Figs. 4 and 5 show a modification of Granger's nozzle designed for very high steam pressures, and in which the continuity of the annular jet is interrupted and the steam escapes in several small independent jets (four are actually shown in the engraving), the areas of which can be all

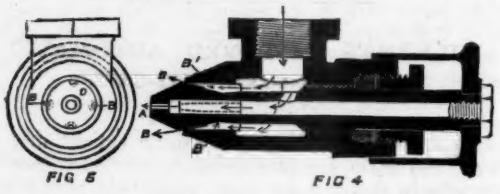


FIG 5 FIG 4

simultaneously adjusted by turning the hand rim. The object of this construction is to prevent the extreme thinness of the annular jet when the nozzle is adjusted to the very fine opening necessary for high pressures, because when in that attenuated condition the jet lacks power.

With regard to the application of these nozzles, they may be used for various purposes, such as forcing the draught of destructor furnaces and boiler furnaces, exhausting foul air or gases from rooms, hospitals, chemical works, &c.,

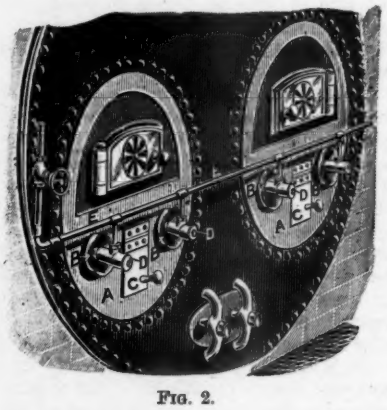


FIG. 2.

withdrawing explosive vapours from petroleum tanks, &c. We give an illustration, fig. 2., showing them applied to an ordinary Lancashire boiler, from which it will be seen that the nozzles, D, D, force the air under each furnace through two air tubes, B, B, the ash pit mouth being closed air-tight by an iron plate, A. In this way the ash pit becomes a species of air reservoir, and the air being under slight pressure (owing to the action of the nozzles), forces its way through the fire-bars and among the fuel, causing a very complete and vigorous combustion. The results claimed to be obtained by this powerful draught are stated to be: 1. Cheap inferior slack and refuse coal can be advantageously burnt so that one ton of slack will produce as much steam as a ton of ordinary coal will do under natural draught, hence the cost (expressed in money) of evaporating, say, every 1,000 gallons of water is much reduced. 2. With ordinary coal the steaming power of the boiler is greatly increased. 3. Small anthracite can be readily burnt, and will give an absolutely smokeless fire. 4. In the case of refuse destructors the strong draught greatly facilitates and hastens the process of combustion.

AVERAGES AND THEIR FALLACY.*

ONE of the great labour saving devices of the editorial sanctum and of the mediocre writer on economics is that of averages. When a subject is complex and the different factors require a laborious weighing to determine their resultant effect, it is so easy to call in the aid of the "happy

* *Electrical World.*

mean," or to strike an average, that sometimes the temptation is almost irresistible to adopt this time-honoured and usually safe method of retreat, which often by a brave air may even be given the appearance of an advance. In most cases, particularly in editorial writing, the reader will be entirely justified in considering that this is a device adopted as an easy way out of a difficulty. In certain branches of statistics it must be admitted that the average is a legitimate recourse, but this is because the difficulty of the case may not admit of other treatment or method of comparison, or that the variations are such as to permit the proper application of the arithmetical mean. For theoretical purposes, however, and, in quite as great a degree, for practical purposes, the average should only be relied upon in the absence of everything else. In science the method of least squares, which may be denominated a scientific average, where applicable, reigns supreme, and in everyday life questions are decided on their own merits without reference to the average solution. In fact, it may be said that the successful man becomes so by the avoidance of averages, of which even nature herself seems to have an abhorrence. The statistician will gravely inform the public that the average wages paid in a certain industry are much below those in another, implying that the latter therefore offers superior advantages to workmen, while in point of fact each grade of labour may be much more highly compensated in the former, and the difference in the average caused by the larger proportion of unskilled labour employed. When applied to engineering operations, nothing is more dangerous from a business point of view than dependence on the average; the average cost per horse-power of water power, steam or electrical machinery, and the numerous other tables of approximate information are often worse than useless, as an estimate based upon them alone will in most cases be either too high and thus cause the loss of a contract, or, what is worse, be too low and cause a direct financial loss. The variation in cost due to quantity, quality, labour and other particular conditions of any case are so great that if the means are not at hand for an estimate based upon exact figures, in many, perhaps most, cases it will be better to avoid making any at all unless there is a desire to include the element of speculation. In this age, when everything is becoming specialised and individualised, and when keen effort is always searching for the advantage to be derived by a departure from average conditions, success depends entirely upon careful scrutiny of details and the strict co-ordination of the special facts of each case under consideration.

INCREASE OF DROP IN ALTERNATING CURRENT CONDUCTORS.

IN almost all works in which the increased drop in conductors carrying alternating currents is referred to, the increase over that due to a corresponding continuous current is ascribed to the increase in resistance following from the unequal distribution of the flow of the alternating current in the cross section of the conductor. This, of course, says the *Electrical World*, is entirely wrong, as the effect of the unequal distribution is entirely negligible with the sizes of conductors and the frequencies used in practice, amounting to only about $\frac{1}{20}$th of one per cent. in a 000 B. and S. copper wire with a frequency of 130 per second. With very great frequencies this factor becomes large, yet the resistance of a 000 B. and S. copper wire is only doubled at 10,000 periods per second. The real cause of the practical drop is impedance, and this Mr. A. E. Kennelly has recently exhaustively investigated for different frequencies and different sizes of wire, the results being given in a paper in the April and May numbers of the *Transactions of the American Institute of Electrical Engineers*. Taking the same wire mentioned above the increase in drop due to impedance with 130 frequencies would be in concentric conductors about 30 per cent.; with conductors separated a distance of 10 inches the drop is more than quadrupled, while for a single conductor suspended 20 feet from the ground it becomes more than six times as great as when carrying a continuous current. With a No. 6 B. and S. copper wire this increase is insignificant in a concentric cable, only 25 per cent. when the conductors are separated 10 inches, and 70 per cent. for a single conductor under the conditions given above. In long lines having considerable capacity these results are considerably modified, but hold true for ordinary lighting circuits. It will be interesting to note the cause of the increase of resistance in each of the two cases referred to. To assist in conceiving of the action within a straight cylindrical conductor carrying an alternating current, we may imagine the whole current to consist of an infinite number of component currents. First consider the increase of resistance due to unequal distribution of current in the cross section of a conductor. Owing to the constant change in the value of these filamentary currents, each exerts an inductive effect on, and is subjected to inductive action from, all others within the conductor. The central filamentary current, however, having a less mean distance from the other currents, is subject to the greatest action, and a current on the surface of the conductor, having a greater mean distance, to the least. As the result of this mutual induction is to set up counter electromotive forces, less current will therefore flow through the centre of the wire and more near the surface, and the greater the rate of alternation the greater will become this disproportion. The consequence of this unequal distribution and resultant greater density near the surface is that the resistance to the passage of the current is increased, following Ohm's law. For example, suppose we have a conductor of a resistance of one ohm; imagine this conductor to consist of a central core and a surrounding cylinder of equal area, each having thus two ohms resistance. Now suppose that the rate of alternations of a current of 3 ampères passing through the conductor is such that 1 ampère passes through the central, and 2 ampères through the cylindrical, part. If the current were a continuous one the energy lost through resistance would be $3^2 \times 1 = 9$ watts; in the assumed case, however, the energy lost will be $(1^2 \times 2) + (2^2 \times 2) = 10$ watts, and as the currents flowing are equal in the two cases the resistances will be in the ratio of the watts, or as 9 : 10; in other words, the conductor will have a real increase of resistance of about 11 per cent. due to crowding the current into a smaller area. It should be noted that this is not a contradiction of Ohm's law, but, instead, a result of it. The drop due to impedance, which is, as remarked before, much greater than in the case just considered, results from the fact that every circuit carrying a current is a closed loop, and the increase and decrease of the lines of force in this loop, due to the current alternating in strength, sets up a counter E.M.F., the effect of which is an apparent increase in the resistance of the conductor. The nearer together the two conductors of a circuit are the less lines of force will be enclosed by the loop and therefore the less back E.M.F. will follow from their variation. It will be seen that the increased apparent resistance due to alternating currents may become a serious factor, but by using small wires and keeping them close together the effect may easily be kept within practical bounds.

PRODUCER-GAS ENGINES AND THEIR APPLICATION TO CENTRAL ELECTRIC GENERATING STATIONS.

UNDER the above title, M. E. Hospitalier contributes an interesting article to *L'Industrie Electrique*, upon the general importance of gas engine power as a substitute for steam engine power as applied to electric generating plant. Up to the present the heat energy of the coal burnt has, in general, been transmuted into mechanical energy through the intermediary of steam, but it does not by any means follow from this that steam is the most simple and the most economical. We know that from the point of view of efficiency, and leaving the relative cost of fuel out of consideration, a gas engine using ordinary town gas is very superior to a steam engine. The relative efficiency of a gas engine may rise to 18 per cent., whereas that of a steam engine has never been known to exceed 9 per cent. But ordinary town gas is an expensive form of fuel, so much so that the increased efficiency is not sufficient to counterbalance the increased cost. It is therefore obvious that to justify gas engine power, it is necessary to use some form of gas in which the decrease in

price is proportionately very much greater than the decrease in calorific power. The value of such a gas has been recognised for years past, and has led to innumerable experiments on what might be termed "motive-power gases." These experiments have been in some instances successful, in so far that it may now be considered beyond question that motive power can be obtained by the use of one of the "cheap gases" at a cost very much below anything that has been attained in gas engines before.

This question is one which, of course, is of deep interest to electrical engineers, who, in all large towns have to deal with a problem of very great importance indeed, namely, the reduction of the ratio of power to floor space to a minimum consistent with efficiency. Any details of the working of a central electric generating station are naturally worthy of attention. Such a station has been erected at St. Geniès-le-Bas, in France, which we propose to describe.

M. Hospitalier is of opinion that it is difficult to predict any limit of power to engines of this class, and mentions several 100 horse-power engines now at work, and refers to one of 200 horse-power which will shortly be erected in Paris by MM. Matter, of Rouen.

The producer, A (fig. 1), consists of a cylinder of fire-clay bricks contained in an envelope of tiles, and separated from this envelope by a layer of sand to reduce the loss by radiation of heat as much as possible. The fuel is fed through the hopper, M, N, and falls on the grate, C. Bars placed obliquely at D, D, E, prevent the fuel from falling into the ash pan, and admit of air filtering through the fuel, which is kept at red heat. A small jet of water is introduced at W, and falls on to E. A part of this water is converted into steam, which penetrates into the incandescent mass of fuel and is there decomposed. The excess of water runs off at J. It is necessary to so regulate the cock at W, that some excess of water runs off at J, in order to be quite sure that enough water is being supplied at W. A fan, driven by the engine, supplies a current of air to the furnace. This air enters at H, and carries the steam with it through the burning fuel. The carbonic oxide formed combines with the hydrogen, the hydrocarbons present and the nitrogen of the air, to form a gas of the following composition :—

H	= 20·00	
CO	= 21·00	45 per cent.
C_2H_4	= 3·50	
C_4H_4	= 0·50	
O	= 0·50	
CO_2	= 5·00	55 per cent.
N_2	= 49·50	
	100·00	

This gas may be termed a poor gas, as its value as an illuminant is very small. It is, however, eminently suitable for motive power.

Its calorific value is about 1,500 calories per cubic meter. This figure will of course vary with the quality of coal used, and is taken from an analysis of the gas as produced from Welsh anthracite coal. The gas passes from the producer through an apparatus, B, where it is washed. Any back movement of the gas is prevented by the water seal T. The washer, B, consists of a column of coke through which water is continuously trickling. From B the gas flows to the gasholder. Arrangements are provided for the renewal of the coke when necessary and the coke taken from B is mixed with the fuel to be used in the producer. The gasholder should always be kept full, so as to be ready for a start at a moment's notice and to allow for the blowing up of the gas producer to the proper working temperature. Provision against an unnecessarily rapid production of gas is made in the following manner: at the bottom of the producer a relief valve, I, is fixed on the air delivery from the fan, which is arranged to lift when the gasholder has reached its full height. The air from the fan blows through into the atmosphere, and a proportional diminution in the consumption of fuel is effected.

The producer requires recharging every four to six hours, according to the size of the apparatus, and every 24 hours the ash pit is emptied and the fire cleaned. A great saving in labour may be effected owing to the automatic action of the apparatus, a matter of considerable importance in large installations.

The upkeep of a producer compares favourably with that of a steam boiler. There need be no leaks, as the gas is stored

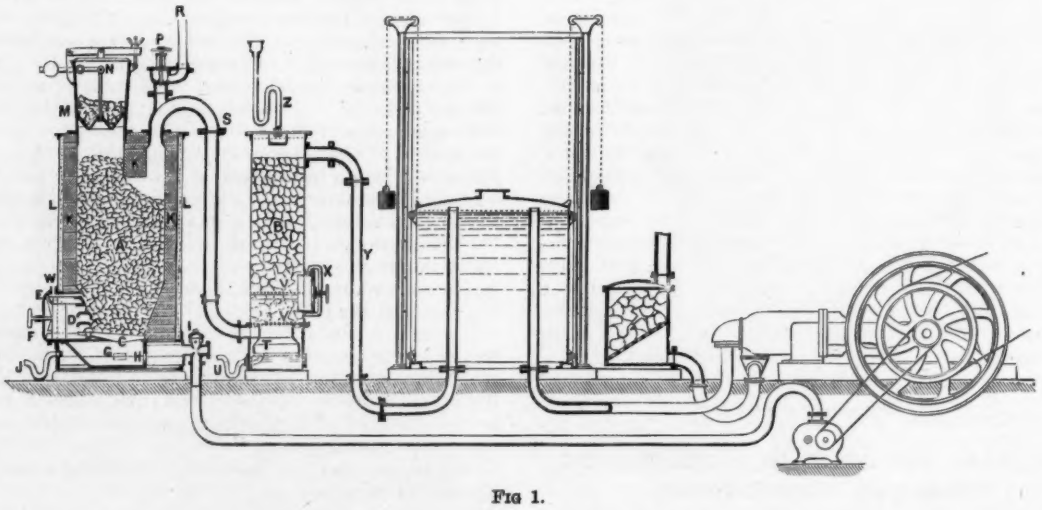


FIG 1.

in the gasholder at a very slight pressure above the atmosphere. There are no tubes to burst, no explosions to be feared, and no expensive repairs to be met or to be provided for. When the engine is stopped the production of gas must also be stopped. In order to do this the valve, I, and the damper, P, are opened slightly, thus admitting a feeble current of air through the producer during the period of rest, by which means any unnecessary consumption of fuel above that required to keep the fire just going is avoided. When the engine is again started, the fan very quickly brings the producer up to the proper temperature for the production of good gas.

Originally only English anthracite was used for producing "poor" gas. But it has been found that very fair results are obtained by the use of coal inferior in bituminous matter to anthracite. Such fuel is of course much cheaper than anthracite. Anthracite coal contains sulphur and if this is present in any considerable quantity a more thorough system of purification of the gas would be necessary. It is also of very great importance that the fuel used should be one that does not cake, otherwise the air space between the fire bars would soon be choked and would necessitate frequent attention.

Bituminous coals tending to deposit tarry compounds on the walls of the producer should be avoided altogether. It has been found that such coal as is found in the neighbourhood of Liège and of Charleroi are suitable for use in a producer.

On analysis, various combustibles used in this installation have been found to contain from 2 to 11 per cent. of ash and from 6·5 to 8·5 per cent of volatile matter.

At St. Geniès-le-Bas a "simplex" gas engine constructed on MM. Delaneare-Debouttevillle and Malandin's system is fed by gas made in a Buire-Lencauchez producer. The dynamo used is an eight kilowatt gramme. The simplex engine works with the Otto cycle, and is fitted with a self-starter. The consumption of fuel is about 700 grammes per brake horse-power hour (about 154 pounds). During 18 hours of no load the fuel consumed in the producer was 40 kg. (88 pounds) or rather less than that necessary to raise steam in a boiler of corresponding size. Two other stations equipped with gas engines of 60 horse-power are in course of construction, one at Villeneuve-les-Béziers and one at Carignan.

THE COST OF STEAM POWER WITH VARIOUS TYPES OF ENGINES.

THERE was presented at the March meeting, in New York, of the American Institute of Electrical Engineers, by Dr. Chas. Emery, a paper of very considerable interest. Anything which Dr. Emery has to say on the question of steam power is deserving of notice. In the present case he has endeavoured to arrive at the commercial cost of steam power produced under various conditions as to type of engine, or of boiler and of fuel cost.

As a unit of comparison he has taken 500 net horse-power, the net horse-power being that which would be delivered at a brake, placed upon the crankshaft in case of direct coupled engines, and upon the jack (second motion) shaft in slow speed engines, a speed of 250 to 350 revolutions being in each case assumed. To get this net power of 500 it is assumed that engine friction absorbs 8 per cent. in high speed engines, and 10 per cent. in low speed engines, the indicated horse-power being thus set down in the two cases as 542 and 556 respectively, though we find that these figures give frictional percentages of nearer 8½ and 11, the true figures to yield 500 horse-power being, we should say, 543½ and 555½ indicated horse-power.

The pressures are taken at from 100 lbs. for simple engines up to 170 lbs. for triple expansion engines. The boilers are supposed to evaporate 30 pounds of water hourly at 70 lbs. pressure from a feed at 100° for each rated horse-power as adopted by the judges of the Centennial Exhibition.

The boiler power required by different engines is thus found to vary from 596 per engine unit for high speed non-condensing engines to as low as 259 for the best type of triple expansion condensing engines.

A very elaborate table is worked out, showing the cost of one horse-power per year for different engines when operated 10 hours daily for 308 days annually, and 20 hours daily every day of the year, with coal at 2, 3, 4 and 5 dollars per ton, *i.e.*, from 8s. to 20s. per ton (2,240 lbs.)

Not only are the results given for the case of no surplus plant, but also for the supposititious case of 50 per cent. surplus machinery to supply a short maximum demand.

Boilers are supposed to be obtained and fixed complete for work for $22 (£4 10s.) per commercial horse-power, as above noted, but for pressures above 125 lbs. they would cost $25 (£5 2s.) It has been difficult to arrive at prices for engine power, but it is quoted from advance sheets of Mr. Schlesinger at from $50·40 to $61 per horse-power for high-speed non-condensing engines and boilers. Dr. Emery finds $58·90 for such engines with sectional boilers. Mr. Pearson of the West End Railway of Boston finds $75 per horse-power, including buildings and surface condensers. In computing fuel costs, evaporation is assumed at 8½ lbs. of water per pound of coal, and additions are made for taxes, promotion and other initial expenses, supplies, ordinary repairs, wages, &c., whilst for interest and dividend the rate is fixed at 10 per cent. as "none too high for capital invested."

Taking everything into consideration, it is remarked how uniform the total cost of steam machinery of different types is found to be, and also that the least costly machinery is that of fairly good economy. Condensing engines come off easily the best, however, but very high-class engines are so expensive that, despite their reduced boiler cost, they exceed the moderate plant in total price. If Dr. Emery's assumptions have been well chosen, it would appear that for coal at $2 per ton, moderate priced compound engines are commercially the best. As coal becomes dearer, more costly and economical engines begin to draw into line, and finally, for $5 coal, to pass the compound engine, especially for long hours. In drawing conclusions, the author states there is no economy in poor material or cheap work. The tendency to put in numerous details is to be checked. Such details, though of small individual cost, come in the aggregate to a large sum, and fuel saving devices are not to be purchased which will not annually save a fourth of their cost. It does not seem possible that the triple expansion engine, when worked non-condensing, can, for irregular loads, show an economy over non-condensing compounds, unless pressures be carried above 200 lbs.

Generally, the tendency of the paper is to warn against an over refinement in seeking after fuel economy by expensive plant and adjuncts; it is decidedly unfavourable to non-condensing practice, especially for variable loads, such as is so much electrical work, and it points to the rapid reduction of any economy of fuel on one hand by the increase of interest and other charges which accompany the more economical machinery.

Long hours, dear fuel, and expensive land and building charges, are the conditions which best help the economical engine to justify its selection. Thus, for City work and expensive fuel, engines of good economy are warranted. We do not think that quite sufficient stress has been laid on the fact that engines of high economy are very readily made into steam eaters when not kept well up to a condition of excellence. Dr. Emery does not include in his consideration the engines of steam ships, for he very rightly observes that the conditions are quite different. An economical engine on a ship means less room occupied by coal and more space available for paying cargo.

As localities are brought nearer to coal fields, so will the necessity for specially economical engines disappear. Though coal in England is, perhaps, cheaper than in America, we are ourselves inclined to think that the sphere of the economical engine is much in this country as it is in America, for here, invested capital is content with a smaller return in interest, and it will often be possible to secure what may be a paying result by an expenditure which in America would not receive the expected interest. Consequently, high class engines have, probably, about an equal field in either country. It is, therefore, probable that Dr. Emery's paper may be taken as fairly applicable to England and worthy of careful study.

The tables of results are too bulky for reproduction and cannot well be abstracted.

There is a most interesting supplement upon water power, from which we learn that at Lawrence the works to utilise the Merrimac River have cost something like $77 per horse-power and at Lowell even more than this. This, too, was apart from the turbines and users' expenditure generally, so that the total cost has been $142 per horse-power which may be, and is, increased by supplementary steam plant.

Water-power will not, it is stated, warrant a cost of more than $140 per horse-power on a 10 hours' basis of use daily, for this figure with additions for repairs and taxes, brings the annual cost to $23·80 per annual horse-power, and this represents the cost of steam power with coal at $2 to $3 per ton. When, however, the power can be used for 24 hours per day, a much higher initial cost is warranted. This is a very important consideration for electrical engineers, and Dr. Emery has not hesitated to advise so high an expenditure as $200 per horse-power where power could be sold during the day and light sold at night, but each case requires separate consideration.

The importance of securing a day consumption of current cannot be too much insisted on, as well in cases of water-power as of steam plant. In this respect electricity has the same advantage as gas in that light or power can be drawn from one lead. The whole teaching of the figures which are presented is strongly in the direction which has already been pointed out in our columns, a more diversified use of power plant generally, especially of steam boilers which will supply steam as easily for one purpose as another, whereas we have boilers which now work by day and others which work by night, when one set would as well, in fact better, work continuously, with less wear and tear.

THE ELECTRIC LIGHT AT CAPE TOWN.

IN the spring of 1892, the Municipal Council of Cape Town resolved to carry out extensive electrical works. After a loan of £250,000 had been obtained in London, a number of the leading electrical firms were invited to send engineers to Cape Town, and, after examination of the very peculiar local conditions, to submit to the Council projects for the contemplated electrical works.

The firms who took part in the competition were Crompton and Co., Thomson-Houston and Company, Woodhouse and Rawson, and Siemens and Halske, of Berlin. The preference was given to one of the three projects submitted by Siemens and Halske. The first of these projects had in view an alternating current with transformers; the second a continuous current three-wire system, with four sub-stations of accumulators; and the third, which received the preference, a continuous current five-wire system with a primary system at the distance of 2 kilometres from the centre of the city, and an accumulator system situate in the city itself. This last project, though not the cheapest, received the preference, as it could be recommended by Siemens and Halske, in view of the experience obtained at the central stations of Vienna-Neubad, Vienna-Leopoldstadt, Vienna-Maria-Hilf and Trient, and also of the experience gained at Paris, Clichy, by the Compagnie Alsacienne de Constructions Mecaniques, and further, because the mayor of Cape Town had satisfied himself of its actual advantages in several of the above-named towns. For motive-power, there is a constant water power derived from the Tessina stream, rising on the Table Mountain. A fall of 1,350 feet is available. A pressure tube conveys the water to the turbines set up at the central station. Two turbines with horizontal axles are constructed, each directly coupled with a continuous current dynamo of about 135,000 watts, or about 200 effective H.P., at 250 revolutions per minute. Reserve steam power is provided. The current produced by the dynamos is conveyed to the accummulator sub-station in the city by a main 2,140 metres in length. It consists of Siemens's patent double lead covered cables of 2 × 95 square millimetres of copper sheathed with iron. In this there will be erected a battery of accumulators (272 Tudor cells) of a discharging capacity of 468 ampères and 1,404 ampère hours, as also the apparatus for regulation and distribution, by which the current is conveyed through the main leads to the chief points of distribution.

All the main and distributive mains in the principal streets are laid underground, whilst the remainder of the mains, consisting of bare copper wire, are fixed on iron masts supplied by Siemens Brothers, of London. The total length of the underground mains is 35,985 metres; that of the aerial leads is 244,800 metres. The installation is to supply 6,000 lamps, including 400 glow lamps at 25 and 35 candles, and 30 arc lamps at 8 ampères for lighting the streets. The entire installation must be so far advanced by December next year that the supply of light may be effected to all consumers connected, and the street lighting must be undertaken to its full extent. So long an interval for the completion of the entire installation has been stipulated, because the motor arrangements, especially the water works, will take the chief share of the time.

THE RETURN FOR ELECTRIC RAILWAYS.

IT is hardly necessary to make any apology for offering to our readers a few remarks on the subject of the ground return for electric railways, based chiefly on American practice. The present moment seems to be a singularly appropriate one. The recommendations of the Lords and Commons Committee which has been considering the uninsulated return for traction will no doubt seriously affect the traction question, though we would hesitate to say that however opposed the committee may be to an insulated return, it will prevent the extension of electric tramways.

We shall deal with the whole subject of traction and telephones at the proper time, which will be when the report of the committee is issued.

The subject of the return circuit has been one of burning interest to American street railway men for the past twelve months. Although there has been much said and a good deal written upon the matter, it can be by no means considered to be settled one way or the other. So important did the subject appear to the Street Railway Association, that they appointed a committee of experienced men to investigate, among other things, the subject of the best return for electric railways.

There are about three practical methods of ground returns which are used in America. The first is simple bonding of the rails together, as shown in fig. 1. The wire is very often

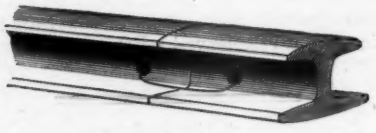


FIG. 1.

soldered to the rails, but the experience is, that this soldering gives rise to some trouble or other. This is, to some extent, obviated by fixing the bond wire into the rails by means of channel pins. Copper or iron wire is used as the bond, but copper is preferred, the iron being speedily corroded.

In addition to the bonding, other railway men have fancied that by laying a supplementary wire between the rails, and connecting each bond wire to it, they improve the return. This system is mostly adopted in the States, although there are many who say that supplementary wires are useless. On some electric traction systems, not only have the bonding and supplementary wires been used, but return feeders have been connected to the supplementary wires at different points along the road. We will not stop here to comment on the reasonableness of such an arrangement, the principle of which is that you must use as much copper for return as for outgoing purposes. It is needless to say that this system has been severely criticised by engineers, and we shall in the course of this review give the chief objections to it.

The American committee, just mentioned, without hesitation recommend the supplementary wire. The two rail joints should be bonded with a soft copper wire. A connection should be made to the supplementary wire at least every fifth rail. It is also recommended, as a safeguard against possible break in the supplementary wire, to connect both sides of the track, and if a double track, to cross the opposite track, and to the supplementary wire of the opposite track every 1,000 feet. They had heard of instances being cited where copper wire laid underground was more susceptible to electrolysis than one of galvanised iron or steel, but the conclusion of the committee, based on experience, is that copper is not only a better conductor, but less liable to corrode than iron or steel. The committee lay stress upon the connections to supplementary wire; the more connections to the rail and the opposite poles of the generator with the moist earth, the more economical is the system operated.

Mr. G. R. Wheeler has paid much attention, and made many practical experiments on this subject. In his opinion, recently given in the *Street Railway Journal*, the return circuits may be so constructed that the coal consumption will be largely in excess of that required to operate the road, and, of his own knowledge there are a large number of roads now operating with bare expenses, much in excess of what they should be on account of unbalanced circuits.

What Mr. Wheeler suggests from his experience and many experiments is the following method:—Drill in the rails, about 18 inches from each end, a hole $\frac{9}{16}$ths of an inch in diameter, with a twist drill, and connect to each rail a soft drawn bare copper bond wire by means of a channel pin; placing the bond wire in the hole from the inside of the track, and driving the channel pin in from the outside, secures it firmly to the rail without the use of solder. This is a very decided advantage gained over other methods of binding, as there is no possible chance of connections corroding as there is when solder is used. The cost of labour is also largely reduced, as the connection can be made in a very short space of time. In addition to this the rails are cross connected every 300 feet, connection being made to the bond wires at these points by means of a copper wire the same size as the bond wire. The cost is low, considering

the carrying capacity of the copper. In addition, the following earth return is recommended on roads of over 5 miles:—An old car wheel is placed deep enough in the soil between the tracks to reach moist earth; there are fixed to it by means of channel pins two or three copper

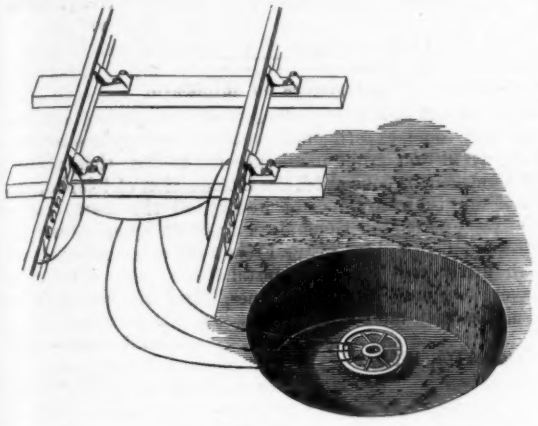
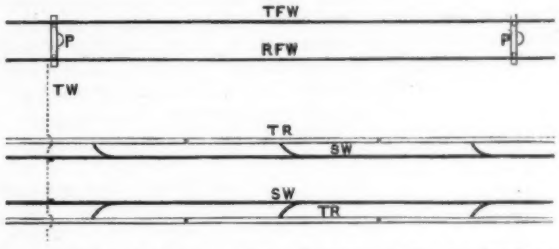


FIG. 2.

wires which are connected to the bond wires (fig. 2). At the generating station several car wheels are sunk in the moist earth, the number being determined by the number of wheels placed between the tracks; these are connected by wires of sufficient size to the negative side of the generators. This will in addition to the rails and bond wires give an earth return which will largely assist in the economical operation of any road. This form of construction has been used with advantage on many large roads. On roads where track feeders are required, it is advisable also to instal supplementary wires placed in the centre of the track, and connected to each bond wire. Good results have been obtained by use of river returns, in addition to the rail and earth returns. If a river runs adjacent to any point of the line and the generating station, it would be useful to sink in the river bed old car wheels or metal plates, copper preferred, of sufficient area, and connect the same to the bond wires by means of No. 0 copper wires. A similar connection should also be made with plates or wheels at the power-house, and the same should be connected to the negative poles of the generator. The writer condemns the practice of connecting the negative side to the motors, and using the rail as positive. Some examples are given of electrolysis, by which copper wires were eaten away. Great attention should be given to the bond wires after the track has been put in operation. They should be frequently inspected, and at night they can be discovered, as there will be always a flash at the wheels when the motor car is passing over. Incidentally Mr. Wheeler mentions a marked decrease in the amount of current used during rainy weather. This is due, no doubt, to the fact that the moisture assists in making a perfect contact between the wheels and the rails, and also allows the current to pass defective bond wires by way of the earth. A great many of the larger roads use water tank car, which is arranged to allow a flow of water on both rails, thus keeping the rails wet at all times. On these roads it has been found that considerable less power is required to operate, and there is an entire absence of sparking at the wheels. It is said that a saving of 33½ per cent. on a rainy day has been obtained.

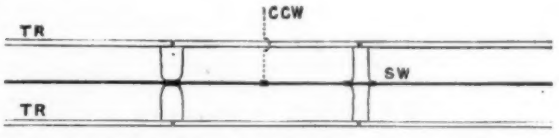
It has been suggested that old disused rails buried in the ground would form a very suitable return; and, no doubt, if a number having together sufficient cross-section could be laid at low cost, there might be considerable advantage in using them.

In fig. 3, a system of track wiring suggested by Mr. Wason, an electric traction engineer, is shown. It requires little explanation. In addition to the supplementary wires being connected to each rail, there is a return feed wire. Mr. Wason is accounted a man with a good deal of experience and his views have met with some approval. A similar system is shown in fig. 4 which has been used in America. The opinions of Mr. Wason are strongly opposed by many practical men, for in the very last number of the *Street Railway Review*, Mr. James Riley, a traction expert, ridicules the notion of running overhead return feeders. "Because," he says, "they have in the rails, if properly bonded, conductors that will put to shame any economical or reasonable system of overhead feeders." Some men have such a liking for the use of copper, that they would ignore the conductivity of the rails entirely, and would run copper wires alongside of, and connected to the middle of each rail, an arrangement having 90 per cent. less current carrying capacity than the rails, if properly bonded. Present bonding methods, continues the writer, are undoubtedly defective, but the line of improvement should be towards perfecting bonds, and not in investing money in overhead copper that furnishes comparatively poor conductivity unless installed in quantities that would ruin the financial standing of any road." The opinion of this writer is shared by a good many other authorities, and a writer in our contemporary, the New York *Electrical Engi-*



T, F, W, Trolley feed wire; R, F, W, Return feed wire; P, Pole; T, W, Tapping in wire; T, R, Track rail; S, W, Supplementary wire.

FIG. 3.



C, C, W, Cross connecting wire; T, R, Track rail; S, W, Supplementary wire.

FIG. 4.

neer, recently concluded an article on this subject by saying, "That the use of a continuous wire with each rail in addition to bonds—commonly recommended as best construction—is not only much more expensive, but considerably less efficient than thorough bonding alone."

What American engineers have sighed for is a continuous rail which would do away with the bonding arrangements, which sooner or later are a source of trouble. It would seem that a continuous rail might eventually give more trouble than the bonding arrangements, on account of expansion and contraction. Experiments, however, have been made which show that continuous tram rails have been held intact by the surface friction of the surrounding roadbed, and for a long period they have shown no movement whatever. Of course, there is a source of danger in a track like this, for it must at times be like a huge spring under tension, and if the roadbed were disturbed at any time there might be a fearful accident. The American railroad engineers have had a good deal of trouble from electrolysis, the copper bond wires being frequently eaten away in an incredibly short time. Water pipes have in many instances suffered, and they are coming to the conclusion that to prevent electrolysis the best way is to connect the water pipes to the rails in as many places as possible.

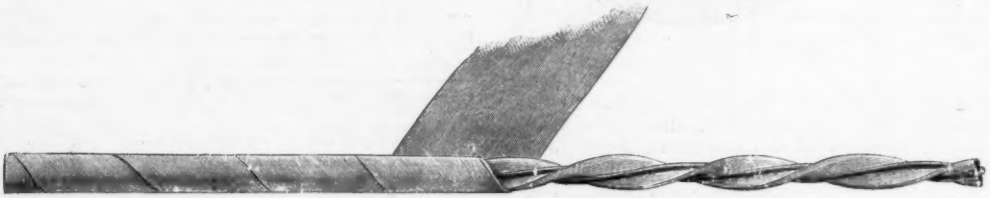
With reference to the unsatisfactory results which are obtained by a soldered connection, it would be interesting to know what means are adopted for effecting the soldering operation. It is an extremely difficult matter to solder on to a large mass of metal, and, in most cases, what is called a soldered joint is not so in reality, the rapid conduction of the heat preventing the solder from "wetting" the surface of the metal against which it is supposed to adhere, and the result being a very imperfect mechanical joint only. As regards the use of the earth return, unless the current density from the earth plates is small, rapid polarisation must set in, which would cause a considerable skin resistance on the plates. To make this current density small the surface of

the plates must be very large, and it is very doubtful if the plates which have been used really approach the surface, which renders polarisation nugatory. Again, how are the leads connected to the earth plates or chariot wheels? Are the connections only mechanical, or are they also soldered? If mechanical only, what means are taken to prevent the buried joints from becoming moist, as they would be very likely to do?—in which case electrolysis would, of course, set in.

CORRESPONDENCE.

Paper Insulation.

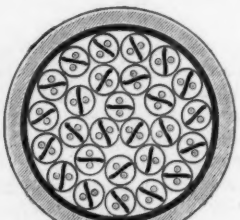
In your issue of the 2nd ult. you make reference to a form of lead covered cable with paper insulation, invented by our firm, viz., our patent air space and paper insulated cables. You mention in particular the arrangement in groups of four conductors, but as we also produce these patent cables with the conductors arranged in "pairs," we send you a block



CABLE WITH TWO CONDUCTORS.

each illustrating a pair of conductors and the section of a cable composed of such pairs.

However, our main object in addressing you relates to your article in the same issue on long distance telephony. In this article you touch upon the question of a suitable cable for submarine purposes, and as we have invented a cable which we claim to be *the* cable for submarine telephone work,



SECTION OF CABLE COMPOSED OF PAIRS OF CONDUCTORS.

we trust this will be deemed a sufficient excuse for our troubling you.

We are sending you also a block showing the section of our submarine telephone cable. You will perceive that we have selected the type of paper insulated groups of four conductors, similar to the illustration in your issue of June 2nd. The group of four conductors is covered with a lead tube covered in turn with a double layer of gutta-percha. The

SUBMARINE TELEPHONE CABLE.

sheathing or armour is composed (under patent) of very strong interlocking iron or steel wires. Thus, while the insulation of the wires is effected by air and paper, and watertightness ensured by the covering of gutta-percha in combination with the lead tube, the sheathing is so constructed as to take up in itself any pressure to which the cable may be subjected, rendering the cable incompressible, which is very important, considering that it is a hollow structure and one which cannot be obtained by ordinary round wires.

Felten & Guilleaume,
C. STUHM.

July 4th, 1893.

Telephones on Shipboard.

Mr. Newitt in his interesting communication of last week mentions some experiments made with telephones on board ship. Will you grant me permission to state that, as far as the Continent is concerned, the introduction of telephones on board ship is already ancient history, all the steam packets of "La Compagnie Générale Transatlantique," as well as a great number of ships in the French and other navies, having been fitted with telephone installations years ago by the Société Générale des Téléphones," and in every case the result has been most satisfactory.

G. A. Nussbaum.

July 11th, 1893.

Contract for Lighting Paddington Baths.

With reference to a notice in your issue of last Friday, respecting the closed contract for lighting Paddington Baths, we write, in justice to ourselves, to explain that although our tender of £72 was apparently the lowest, yet actually it was not so. We drew up our tender according to the specification which was sent to the three competing firms, whereas we are given to understand that the successful firm exceeded the specification in three important details.

Sotheby & Ridout.

July 12th, 1893.

Practical Electrical Engineering.

I last week received the second volume of the new work on "Practical Electrical Engineering," and you may judge of my surprise and disappointment in looking through it to find that in this book (which, to use the words of the prospectus, "In a word this book is intended to be the 'classic' upon all that relates to 'practical electrical engineering'") there is absolutely nothing on the design of alternators or transformers, except that Mr. Kapp's excellent section on continuous current dynamos is headed, "Dynamos, Alternators, and Transformers," and that in the first volume there is a plate of a Mather and Platt alternator. Surely the editor of this work does not think that the alternate current system, which is so much in vogue in England, Europe, and America, is impractical and does not come under the heading of "practical electrical engineering."

George Weymouth.

July 3rd, 1893.

Gas Engines.

Your correspondent thinks I have not been fair in stating that the gas engines described by him are not up to date. He is also pleased to say that I must now be mollified by having a notice of my own engine inserted in his articles. I hope I am not ungrateful, but, truth to tell, I am not mollified, and would have been better pleased had Mr. Spies omitted any mention of my engine. The description of it is taken from an issue of the *Engineer* two years old, word for word, and the illustrations are taken from the same paper, line for line, without a word of acknowledgment.

The engine described then was old, and the method of governing was only an experimental fancy, and of no practical

value, yet, forsooth, Mr. Spies thinks it is our latest and best method.

So far as I can see your correspondent's articles are mere pieces of padding. The descriptions of the various engines are taken from publications and gas engine makers' catalogues without any attempt being made to verify things.

While I am writing I am tempted to say something about your own article in this week's issue of the REVIEW, on the "Use of Gas Engines." You complain that they are not used so much for independent electrical plants as you and others expected. So far as our own works are concerned we don't complain about this, though I have no doubt much more extensive use could be made of gas engines in this direction than they are at present. Two things stand in the way (in my opinion), the first is the prejudice which electrical engineers have against gas engines for their work, and the second is that the four-stroke or Otto cycle engine is quite unsuitable for such work, where extremely close governing is required. As a fact it is well known that an Otto cycle engine cannot run incandescent lamps direct without fluctuation of light and the engine to govern at the same time.

The favourite method at exhibitions, and elsewhere, is to fasten the governor down so that the engine works at full power; with light loads the combustible mixture is weakened a certain amount to reduce power and ignite the charge every two revolutions. Neither method is economical, but greater steadiness is obtained than would be the case if the governor were allowed to act.

So far as the first cause is concerned, I am pleased to say that I think the clouds are breaking, and electrical engineers are beginning to look on us more favourably, and I hope this will go on and continue.

Hugh Campbell.

NOTES.

Just the Difference.—It is said that there are certain companies in France which pay fees to their shareholders for attending meetings. As much as 10 francs a head was paid the other day by a telephone company in France to its shareholders. On this side directors would often gladly pay shareholders a small fee to stop away from meetings.

Bravo Cork!—Perhaps the most exciting incident to record this week, save the lightning effects, is the decision of the Cork Town Council to adopt electric traction with overhead wires. The usual "ornamental" bogey was trotted out, but the Council were singularly unaffected at the prospect of spoiling their streets, so the matter will go forward.

The Electric Light at Rotterdam.—The City of Rotterdam has entrusted Messrs. Siemens & Halske, of Berlin, with the erection of municipal electrical works for lighting, and for the transmission of power. The installation is to be carried out on the continuous current 5-lead system, on the applicability of which in the present case the officials of the municipality have become personally convinced at the central stations of Vienna-Neubad, Trient, and Paris-Clichy. From the generating station the current is conveyed 1½, 2, and 2½ kilometres to secondary stations. A subordinate station is chiefly to supply current for lighting to the principal business quarter of Rotterdam. A second station serves principally for working motors for the numerous cranes, turn-bridges, hoists, &c., at the harbour. Messrs. Siemens & Halske hope to hand over the installation in full working order in the first months of next year.

Personal.—Since last July Mr. Claude W. Hill has been managing Messrs. Paterson & Cooper's works, Pownall Road, Dalston, and that is now his business address, instead of 5, Parsonage, Manchester, where, in June, 1891, he commenced work as a consulting engineer. Mr. Hill carried out several installations, and was retained as engineer to the Sims-Edison Torpedo Company. The principal piece of work, however, carried out by him was not electrical, viz., the design and building of the Acrefair Engineering Works, Ruabon, which were described and illustrated in *Engineering*, March 31st last.

Electric Light at Maidenhead.—Messrs. Pritchett and Gold, electrical engineers, of 31, Soho Square, London, have given notice to the Town Council that they intend to apply for a provisional order authorising them to supply electricity to Maidenhead. This should wake up the local authorities.

Mines Accidentally Fired by Lightning.—A startling incident occurred the other day at Chatham, where the Royal Monmouth Engineer Militia are encamped. Three mines were simultaneously fired by lightning. The charges were very large, and the débris was violently hurled over the dockyard extension works. One marine was knocked down and taken to the hospital.

Electric Communication with Lighthouses.—The Commissioners on electrical communication with lighthouses and lightships will begin on Tuesday next their inspection of lighthouses and lightships on the south and east coasts of Ireland and the Isle of Man. They intend to visit Bangor and Belfast Lough, after inspecting the South Rock and Skull Martin light vessels from Her Majesty's ship *Enchantress*. They intend also to anchor in Lough Foyle.

The Cost of Accumulator Cars.—Two weeks ago our contemporary, *Electricity*, ventured to point out that "the use of accumulators for operating tramway cars is much more expensive than the trolley system, &c." This statement has brought a letter from the manager of the Epstein Accumulator Company, in which our contemporary is gently contradicted. The evidence given before the Joint Committee, says the writer of the letter, has furnished the following figures on indisputable authority, viz., that the first cost of electrical equipment per mile of double track is:

On the overhead wire or trolley system... ...	£4,000
On the slot or conduit system	£6,000

while the cost of putting accumulator cars on the road does not exceed £500. Taking, for example, a tram line six miles in length, double track, and the speed of the cars at six miles per hour, including stoppages, so that a car performs the journey in one hour, the relative cost of installation on the various systems will be shown at a glance:

	Per mile.	For six miles.	Number of accumulator cars at £500 for same capital expenditure.	Service provided by accumulator cars.
Trolley system	£4,000	£24,000	48	Every 2½ mins.
Conduit system	£6,000	£36,000	72	Every 1⅞ mins.

A car service every five minutes is considered very quick—every 10 or 15 minutes being usually the rule—but, assuming this to be adopted, then it is quite evident from the above that, to instal accumulator cars on that line, will cost 50 per cent. less than the trolley system and 60 per cent. less than the conduit system, while the running expenses can be proved to compare very favourably with either. The writer of the letter certainly scores a point when he states that the hitherto unfavourable results obtained with accumulator cars have prejudiced the mind of the engineer against accumulators. The following speaks for itself:—"Facts are stubborn things, and the results obtained in practical working with our accumulators during the last 10 months on the Birmingham Central Tramways Company's lines furnish convincing evidence. Many of the batteries now in use, and still doing good service, have completed 6,000 car miles (some more, some less), and not a single one of the 10,000 plates making up the car equipments have been renewed or even repaired since last December—a fact confirmed by Mr. Carruthers Wain, the managing director of the Birmingham Central Tramways Company at the recent meeting of the Tramways Institute. Moreover, this company has undertaken the maintenance of the cells for seven years at the rate of 1½d. per car mile, which is very advantageous to the Tramway Company, and satisfactorily eliminates the only doubtful item in the expenditure with accumulator traction which has hitherto existed, so that the entire working expenses of such a line can now be correctly estimated to within a small fraction of a penny."

The Five-Wire System.—The Paris Compressed Air (Popp) Company is about to erect in the Rue Saint-Roch a central station on the five-wire system, with the use of Tudor batteries.

The Muzzling of a Dynamo.—In view of the approaching introduction of a dynamo, says a contemporary, into the Greenwich Observatory grounds for electric lighting, experiments have been made to determine the possible effect on the magnetographs of the dynamo unshielded, and with a triple iron shield. These experiments were carried out at Messrs. Johnson & Phillips's factory, Charlton, the deflection of the declination magnet of the portable unifilar magnetometer being observed at distances of 20 feet and 40 feet respectively due west—magnetic—of the dynamo, the poles of which were in the east and west direction—magnetic—thus giving the maximum deflecting effect. At the Royal Observatory the poles of the dynamo will be north and south—astronomical—and it will be placed at a distance of about 170 feet from the magnets, and nearly due south—magnetic. Making due allowance for this, the experiments at Charlton would, according to the report of the Astronomer-Royal, give the following results:—

Effect on	Declination magnet.	or	Horizontal force magnet.
Dynamo unshielded ...	... 4′ ...		... ·00008
Dynamo with triple shield	... 0·5′ ...		... ·00001

the effect on the horizontal force magnet being expressed in parts of the whole horizontal force. The corresponding displacements of the magnetograph registers would be only $\frac{1}{2000}$-inch for declination, and $\frac{1}{400}$-inch for horizontal force, in each case with the triple shield to the dynamo. As the separate portions of the triple iron shield were only loosely put together, it is proposed to repeat these experiments with the completed shield, which is now ready. In any case, it seems clear that the shield will so greatly reduce the disturbing effect, as to make it practically insensible.

Electric Traction and Telephones.—Most of our contemporaries have had a fling on this question, and the *Engineer*, in its last issue, delivers itself as follows:—"Anyone reading the articles we have published on the conflicting interests of the telephone companies as interpreted by the Telephone Clauses, and the interests of public convenience by electric traction, will have seen that progress in the latter branch of engineering is impossible so long as these one-sided clauses continue to be inserted. Reading the reports we have recently published of the evidence before the Joint Committee on this subject, and attendance in the committee room, will have convinced many people that the dog-in-the-manger policy followed by a large company without statutory powers is near its end. Of course no one knows yet, but we are sanguine enough to expect that the labours of the committee will have led them to the conclusion that the importance to the nation of cheap transit is so great, that electrical traction progress must be relieved of this telephone incubus." This is no doubt all very reasonable, but we have the notion, mistaken it may be, that if our contemporaries would wait until the matter was decided upon by the committee, they would be less liable to prejudge the case.

A Grand Chance for Amateurs.—We give the following as an unrivalled chance for distinguished amateurs, Sir David Salomons among others. All professionals will be scratched, and if they compete, it is very likely they may be proceeded against under the rules of the National Athletic Association, or some other duly-constituted body:—

CONTRACTS, &c.

MAYORALTY of the CITY of JASSY.—On the 17th August next (old style) the Mayoralty of Jassy will give out a CONTRACT, to be decided by public competition, for the LIGHTING of the TOWN by AERIFORM GAS or ELECTRICITY. Amateurs, therefore, who may desire to take the contract for this concession, are invited to attend at the Mayoralty Hall on the day above-mentioned, between 2 and 5 o'clock in the afternoon, with the offers they intend to make and a deposit of 100,000 francs.

The award will be made by means of sealed offers, in accordance with the form prescribed by the conditions of the competition.

The terms of the competition and the conditions of this concession may be seen at the Chancellor's office of the Mayoralty on all working days.

They will also be forwarded upon application.

pp. LIPAN, Mayor.
A. SOLOMONESCO, Secretary, Administrative Office.
No. 9,174, June, 1893.

The Cable Tram at Brixton.—It is said that the wear and tear of the cables on Brixton Hill is tremendous, and last week, after some attempts to repair the one in use, a new one had to be substituted. These cables cost about £1,200. There is after all a final remedy, and when all the cables in stock have run out, we may expect electricity.

Saturday's Storm.—Much damage was caused by lightning during the storm on Saturday. It was particularly severe in Yorkshire and Lancashire; but from all parts of the country comes the cry of damage. From what we can learn, however, fatal accidents to persons were somewhat rare.

The Remscheid Tramway.—The electric tramway at Remscheid has now been completed, and was opened for traffic on the 8th inst. It is arranged on the Thomson-Houston system, and gradients of 10 per cent. are ascended by the cars. The tramway, which has been constructed by the Union Electricity Company, of Berlin, is the property of a company, half of whose shares have been taken up by the municipality.

An Electrical Sports Club.—Mr. Dane Sinclair recently presided at an enthusiastic gathering of the London staff of the National Telephone Company, at which it was decided to form a sports club, to be called "The Telephone Athletic Association." A provisional executive committee was appointed to arrange details with Mr. T. C. Walker, as treasurer, and Mr. W. E. Deane, as secretary, and a large number of members have already been enrolled.

Tunbridge Wells Electric Lighting.—Last week the Tunbridge Wells Town Council had under consideration a report from the Electric Lighting Committee, which most strongly urged the Council not to allow the control of this matter to pass from the ratepayers' hands into the hands of a private company. The committee therefore recommended the Council to adopt Mr. Preece's plan to supply electricity for both public and private purposes, and to instruct the Town Clerk to apply to the Local Government Board for sanction to borrow the sum of £13,000. The report gave rise to a long discussion, but eventually it was adopted by 16 votes to 9.

Boiler Covering and the Consumption of Coal.—Some experiments on the influence of boiler coverings on the consumption of fuel, says *Scientific American*, have just been concluded on the railways of south-west Russia. It was found that cooling was more rapid while working than when stationary, save when a double covering of felt was used. The heat lost in 24 hours by a boiler with 30 square metres of surface containing water at a temperature of 144°, and exposed to an exterior temperature of 8·5°, corresponded to 133 kilos. of coal if the boiler were uncovered, to 153 kilos. if there were a thin metal covering, to 130 kilos. if there were a double felt covering, and to 103 kilos. in the case of a cork covering. For an average daily consumption of 1,164 kilos., the cooling of the boiler represented about 24 per cent. and 8·1 per cent. of the consumption of coal.

The Electric Light at Torquay.—The Town Council of the Devon watering place have obtained from Mr. Trentham, electrical engineer, of Bristol, a report on the best means of lighting it by electricity. He advises the adoption of the Bath Saloons as the site of the central station. After careful inquiries he came to the conclusion that 1,500 lamps of 16-candle-power would be taken up immediately the current was available. This estimate is independent of the hotels, which, he thinks, would certainly require not less than another 1,000 16-candle-power lamps. Mr. Trentham advises that provision in the first instance should be made for 3,000 lamps of the power indicated. Owing to the length of the streets (5,500 yards), a low pressure system would be unsuitable. Mr. Trentham estimates that high pressure mains, including low pressure connecting mains between the transformers, would cost about £5,000, while the cost of low pressure network and feeders, allowing the usual losses, would be about £15,000. Mr. Trentham predicts that electric lighting will pay its way from the commencement at Torquay, and afterwards prove a very important source of revenue.

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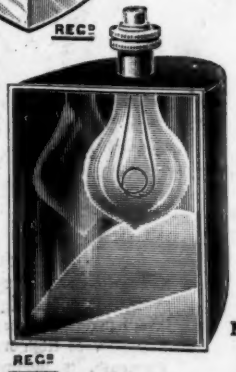

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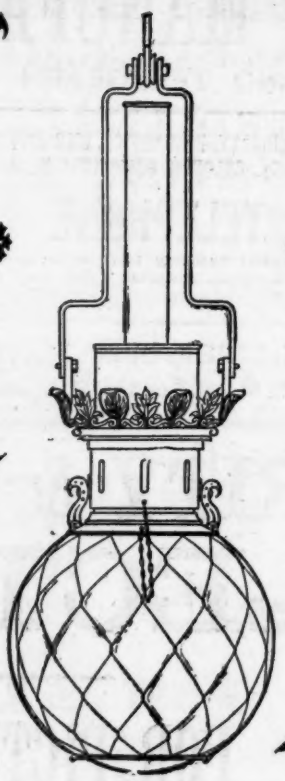

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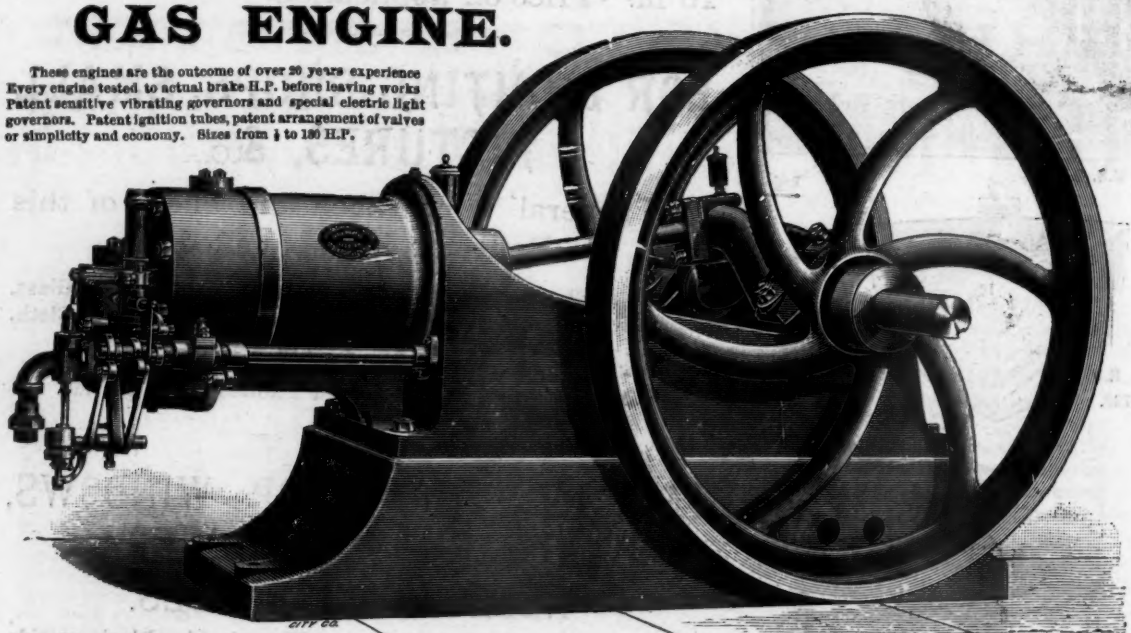

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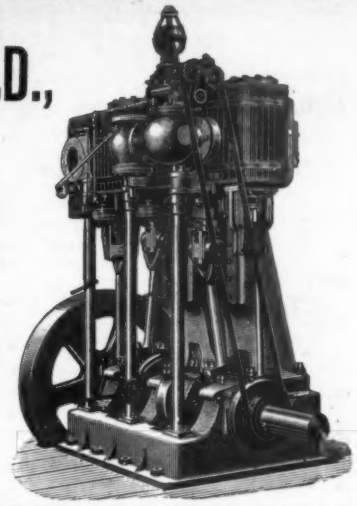

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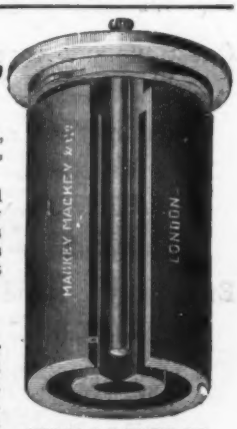

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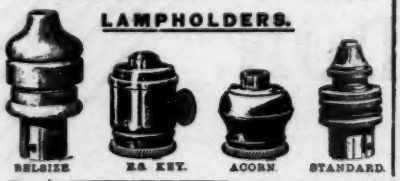

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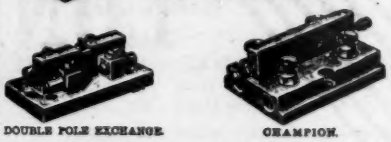

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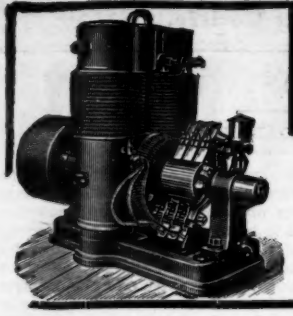

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ELECTRICIAN, willing to invest £200, desires Partnership in a well-established firm, understands dynamos, accumulators, ship and colliery lighting.—Address "C.," ELECTRICAL REVIEW Office. 6396

PARTNERSHIP (active) wanted by Electrical Engineer with small capital; 14 years' experience in manufacturing, installing and maintenance.—6,388, ELECTRICAL REVIEW Office. 6388

PARTNER Wanted.—An Electrical Engineer having just completed a large electrical supply station, requires a Partner with capital to join him in developing and extending his business.—6,402, ELECTRICAL REVIEW Office. 6402

TO Brass Finishers or Others.—Wanted, a firm to undertake manufacture of arc lamps. Particulars supplied on application.—Apply to "ARC LAMP, 6,399," ELECTRICAL REVIEW Office. 6399

FOR SALE, Complete Arc Light Plant, consisting of dynamo, perfectly new armature, four arc lamps with globes, switchboard with ammeter and voltmeter, two resistance frames, quantity of cable; price £45 or offers.—Apply to MCINNES & Co., Stamford Street, Leicester. 6403

A FIRST-CLASS electrical business for disposal, cheap, in a good main road, the proprietor retiring through ill-health; there is a thorough good connection of bell, telephone, and general electrical work.—Apply for particulars by letter in first instance to "WILTON," 5, Ethuard Road, Peckham, London, S.E. 6400

28 Accumulators, 100 ampère hours, £12 10s., shunt dynamo suit above, £12; other accumulators equally cheap; twenty-seven accumulators, insulite boxes, capital little set, fifteen plates each, £8 10s.—JARMAN, 75, Ramsden Rd, Balham. 6359

EDISON American 1883 series dynamo, 105 volts 150 ampères; good order. Offers wanted. Sell cheap.—J. FLETCHER, Electrical Engineer, Burnley. 6376

FOR SALE, Cheap, some 15-L, 11-L, and 7-L Accumulators, several good Dynamos, quantity Cable Instruments, Wire, &c.—HUDDLESTON, Chiswick. 6367

ACCUMULATORS, for all purposes, charged on the premises at reasonable rates.—BARCLAY & SON, 138, Regent Street, and 359, Oxford Street. 6031

WANTED, in good condition, a Secondhand Alternator, giving 10 to 15 ampères at 250 volts at not more than 100 periods per second.—Particulars to the TELEGRAPH MANUFACTURING COMPANY, LIMITED, Helsby, near Warrington. 6358

WANTED, Pivotting, Jewelling, Electricity Meter Trains, Cardew Movements. Experimental and all kinds of fine mechanical work done.—CLARKE BROS., 32, Bravington Road, Harrow Road, W. 6363

INCANDESCENT LAMPS.—A qualified maker is prepared to enter into arrangements to lay down plant and superintend the manufacturing, which process lamps can be produced at 6d. each.—Address 6,383, ELECTRICAL REVIEW Office. 6383

ACCUMULATOR RE-CHARGING.—Cathcart, Peto & Radford are prepared to re-charge sets of accumulators of any size. Electrical power available night and day at all times. Sets of accumulators for theatrical or advertising purposes, &c., charged by contract, fetched and delivered if desired.—HATTON GARDEN ELECTRIC WORKS, E.C. 6372

ELECTRICAL ENGINEERING BUSINESS FOR SALE.

THE Subscribers invite Offers for the Business carried on by WILLIAM M'WHIRTER, at the "Faraday" Electrical Works, Govan, and at 3, Trinity Street, Aberdeen, belonging to the Trustee on his sequestrated estate. The Works are situate in Campbell Street, Govan, and are well appointed. The concern has been valued as follows, viz.:—

AT GOVAN—Ground and Buildings	£700	0	0
Machinery and Plant	1,007	11	4
Stock-in-Trade, Loose Tools, &c.	1,752	15	8½
AT ABERDEEN—Stock-in-Trade, &c.	86	17	2
	£3,547	4	2½

Full particulars will be furnished on application to the Subscribers.

140, Hope Street, Glasgow, NAIRN & BOWES, C.A.
July 4th, 1893. 6382

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR.

ELECTRICAL ENGINEERING.

PROFESSOR A. GRAY will begin in October next a systematic COURSE OF INSTRUCTION in Electrical Measurement and Practical Electricity. The Physical Laboratory is fully equipped with a Compound Steam Engine, Dynamos, Secondary Battery and the most approved modern Measuring Instruments for all branches of Electrical Engineering. Laboratory Fees at the rate of £1 1s. per Term for six hours per week. Composition Fee for all College Lectures for the Session £10.

Applications for Calendar, Prospectus, and general information, to be made to—

6401 J. E. LLOYD, M.A., *Secretary and Registrar.*

Official Notices.

BOROUGH OF WEST HAM.

TO ELECTRICAL ENGINEERS.

THE COUNCIL of the Borough invite applications for the appointment of Electrical Engineer. Candidates must be competent to prepare plans and specifications in connection with the installation proposed to be carried out in the Borough and to advise the Council generally upon the details of the system of distribution. The gentleman appointed will be required to devote his whole time to the work, and to supervise the construction of the proposed central station and other works in connection therewith, and to take charge of such station when completed. Candidates must have had charge of or experience in the working of a station.

The salary will be £250 per annum.

Forms upon which applications must be made may be obtained at my office, and the applications must reach the undersigned not later than 5 o'clock on MONDAY, JULY 17th, 1893.

By order of the Council,

FRED. E. HILLEARY,
Town Hall, West Ham, *Town Clerk.*
July 5th, 1893. 6390

COUNTY BOROUGH OF BOLTON.

THE GAS AND LIGHTING COMMITTEE of the Bolton Corporation are prepared to receive Tenders for the supply and erection of Alternators and Dynamos. Specification and form of Tender may be obtained on application to Mr. J. H. RIDER, M.I.E.E., Borough Electrical Engineer, on payment of One Guinea, which will be returned on receipt of a *bonâ fide* Tender.

Sealed Tenders, endorsed "Dynamos," must be sent to Mr. Ald. MILES, Chairman of the above Committee, at the Gas Offices, Bolton, not later than THURSDAY, AUGUST 3rd, 1893. The acceptance of the Tender will be subject to the contractor paying the standard rate of wages in respect of the work contracted for.

The Committee do not bind themselves to accept the lowest or any Tender.

R. G. HINNELL,
Town Hall, Bolton, *Town Clerk.*
July 10th, 1893. 6397

CITY OF LIVERPOOL.

CITY ENGINEER'S DEPARTMENT.

ELECTRIC INSPECTOR.

WANTED, a well-trained electrical engineer to act as Electric Inspector under the provisions of the Liverpool Electric Lighting Orders, 1891 and 1892, or any future orders or licences that may be granted, and the regulations of the Board of Trade, &c. Salary, £150 per annum, with annual increments of £10 to £170 per annum, subject to a contribution of not exceeding 5 per cent. per annum to the superannuation fund and to the statutory superannuation provisions for the time being in force in the city. Age not to exceed 30 years. The engagement will be determinable by one calendar month's notice to expire on the last day of any calendar month. The person appointed will not be allowed to engage in private practice, and will be required to devote his whole time to the duties of his office. Forms of application and list of duties can be obtained on a written application to the City Engineer, Municipal Buildings, Liverpool. Canvassing of members of the Council will be considered a disqualification.

Applications accompanied by copies of testimonials endorsed "Electric Inspector," and addressed to the "Chairman of the Watch Committee," under cover to the Town Clerk, Municipal Buildings, Liverpool, must be delivered at the Town Clerk's Office, not later than twelve o'clock noon, on Saturday the 29th inst.

By order,
GEORGE J. ATKINSON,
Town Clerk's Office, *Town Clerk.*
Liverpool, *July 12th*, 1893. 6405

COUNTY BOROUGH OF HUDDERSFIELD.

ASSISTANT ELECTRICAL ENGINEER.

THE Electric Lighting Committee are prepared to receive applications for the situation of Assistant Electrical Engineer. Candidates must have had experience in central station work, and be capable of taking charge during night or daytime. Preference will be given to one having had experience in high tension alternate current working.

Applications in candidates' own handwriting, stating age, experience, salary required, and the date when duties can be commenced, accompanied by not more than three testimonials (copies only), written or printed on foolscap, to be addressed and sent in to me not later than MONDAY, JULY 24th, 1893, and endorsed "Assistant Electrical Engineer."

By Order.

H. BARBER,
Town Hall, Huddersfield, *Town Clerk.*
July 12th, 1893. 6408

WOODHOUSE & RAWSON

UNITED, LIMITED.

SUPPLIERS OF

Ammeters.	Holders.	Lightning Arresters.
Voltmeters.	Switches.	Arc Lamps.
Testing Sets.	Cables.	Leak Detectors.
Casing & Cleats.	Wall Plugs.	Automatic Cut-Outs.
Ceiling Roses.	Shades.	Carbons.
Cut-Outs.	Flexible Cords.	Insulators.
Batteries.	Bells.	Telephones.
Dynamos.	Motors.	Resistances.

CORNBROOK TELEGRAPH WORKS, MANCHESTER,

UNION FOUNDRY, KIDSGROVE,

AND 6176

88, QUEEN VICTORIA STREET, E.C.

K.M.B. PORTABLE TESTING SET.

Specially designed for testing insulation resistances by the direct deflection method. Fitted with 4-inch silvered dial, coil of 10,000 ohms, and $\frac{1}{10}$ shunts and contact key. Full instructions in cover.

Price £6 6s. 0d.

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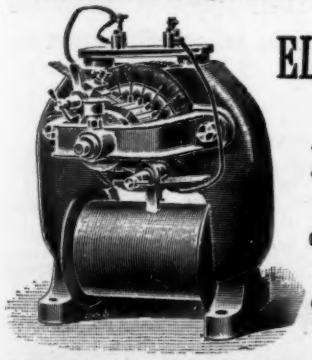
LARGE ILLUSTRATED CATALOGUE, POST FREE 6D. 5736

CUTTRISS, WALLIS & CO., LTD.,

Electrical Engineers & Manufacturers.



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From $\frac{1}{10}$ to 50 H.P.

DYNAMOS
For all purposes.

COMPLETE PLANT FOR ELECTRIC LIGHT AND TRANSMISSION OF POWER.

Contractors for the erection of Bells, Telephones, &c.

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ELMWOOD ELECTRICAL WORKS & 1, BOND PLACE, LEEDS

ROPE AND BELT DRIVING

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PULLEYS, SHAFTING, FRICTION CLUTCHES.

QUICK DELIVERY. LOW PRICES.

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J. BAGSHAW & SONS, Ltd.,
Millwrights and Ironfounders,
BATLEY, YORKSHIRE.
ALSO STRUCTURAL IRONWORK OF ALL KINDS. 6328

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12 FIRST-CLASS MEDALS AWARDED.

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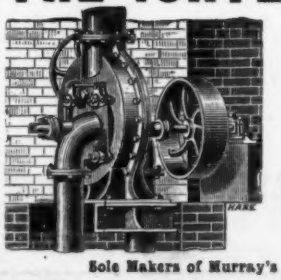
Combs Tannery, Stowmarket.

Price Lists and Terms on Application. 5010

THE VORTEX TURBINE.



This class of Turbine has been supplied for electrical purposes to the Duke of Northumberland, the Duke of Argyle, the Duke of Montrose, Lord Armstrong, Lord Windsor, Lord Abinger, and many others.

Pamphlets, Drawings and Estimates on application,

GILBERT GILKES & Co.,
KENDAL.

Sole Makers of Murray's Patent Turbine Governor.

ZÜRICH INCANDESCENCE LAMP Co.

ZÜRICH.

DIRECTOR:

C. H. STEARN,

Joint Inventor, with Mr. J. W. SWAN, of the modern Incandescence Lamp.

BANKERS:

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AGENCIES:

WITH LARGE DEPOTS OF LAMPS.

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9, Boulevard du Hainhaut.

MILAN:
Signor CARLO PUGNI,
Via Orefici No. 1.

CANADA:
Mr. W. T. NESS,
749, Craig Street, Montreal.

HAMBURG:
Herr W. HOLTZAPFEL,
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MADRID:
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Lamps delivered by postal packets to all Countries within the Postal Union.

Lamps of Long Duration with larger consumption of power or of Greater Economy and Shorter Duration, delivered as required.

Terminals affixed as ordered, to suit any holders of the current types.

The Lamps are manufactured under Mr. STEARN'S personal direction by an English Staff, the Workpeople being partly English and partly Swiss.

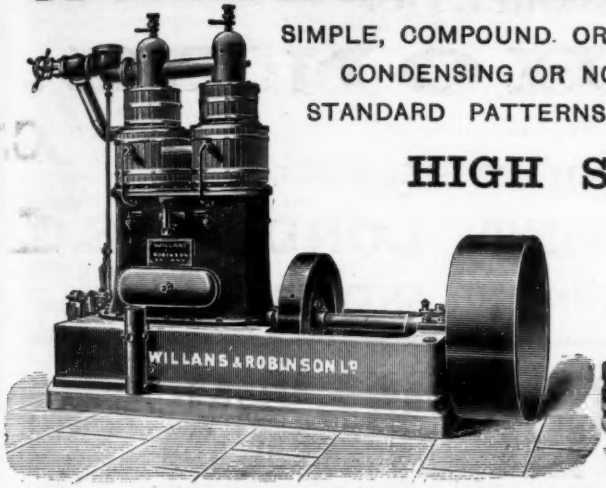
THE Great INCREASE of the Company's BUSINESS in all Parts of the World having rendered an extension of their present premises absolutely necessary, they have purchased a site in Wiedikon, Zurich, where the erection of Stores and Offices will be immediately carried out.

The New Building is expected to be completed early in the spring, after which all the commercial business and despatch departments will be removed to Zürich, the manufacture of lamps being continued at Birmensdorf as hitherto.

ORDERS FOR LARGE QUANTITIES OF LAMPS PROMPTLY EXECUTED.

6062

WILLANS CENTRAL VALVE ENGINES



SIMPLE, COMPOUND OR TRIPLE EXPANSION.
CONDENSING OR NON-CONDENSING.
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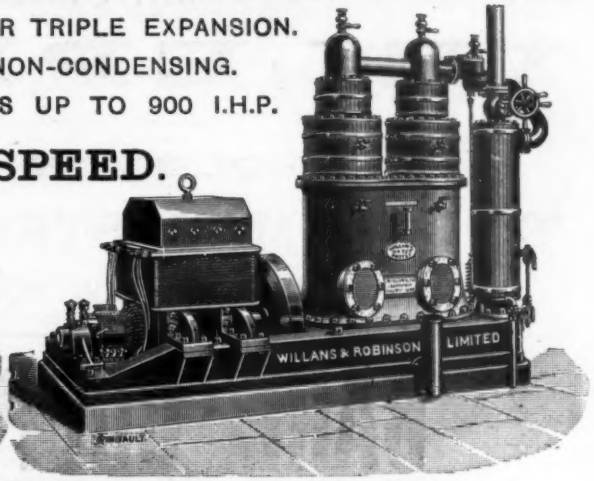
HIGH SPEED.



EXTREME ECONOMY OF STEAM.

(A consumption of less than 13 lbs. per I.H.P. per hour has been recorded under suitable conditions of size, pressure, &c., and even in Engines of 80 I.H.P. a consumption of less than 14½ lbs. can be guaranteed with 160 lbs. pressure.)

GREAT SAVING OF OIL. LITTLE ATTENDANCE REQUIRED.

SMALL SPACE OCCUPIED and corresponding reduction in first cost of buildings.

SILENCE AND DURABILITY, OWING TO ALL BRASSES BEING IN CONSTANT THRUST.

Over 65,000 H.P. in use or on order.

WILLANS & ROBINSON, LTD., THAMES DITTON, SURREY.

6185

INSULATORS

Of all descriptions, combining the greatest strength with highest possible insulation, in Bristol Glazed Stoneware and Special Porcelain Stoneware (White).

ALSO BATTERY JARS, PRIMARY AND SECONDARY AND POROUS CELLS.

PRICE, SONS & COMPY., The Potteries, BRISTOL.

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CHEMICALS.

ALL KINDS FOR ELECTRICAL WORK, and also for INDIA-RUBBER & GUTTA-PERCHA MANUFACTURERS,
Solid Sulphuric Acid and Bichromate Salt for Export.

G. BOOR & Co., 1 & 2, Artillery Lane, Bishopsgate, LONDON, E.C.

CONTRACTORS TO THE POST OFFICE WAR OFFICE, ADMIRALTY, INDIA AND NEW ZEALAND OFFICES AND LEADING TELEGR/PH COS. 3675

CLARKE, CHAPMAN & CO., Ltd.,

ELECTRICAL ENGINEERS.

SPECIALITIES.

Continuous Current Dynamos, Alternators,
Electric Motors,
Slow-speed Direct-coupled
Engines and Dynamos
For Ship Lighting, &c.

SEARCH LIGHT PROJECTORS, ARC LAMPS,
Electric Lighting and Power Transmission.

CONTRACTORS TO ADMIRALTY.

GATESHEAD-ON-TYNE.

[ENGINEERING TELEGRAPH CODE USED.] 6307

WESTERN ELECTRIC CO.,

MANUFACTURERS OF

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CHICAGO, NEW YORK AND ANTWERP. 1906

BARE COPPER MAINS.

It has recently been stated in certain trade circulars that the "advantages claimed for systems of copper strip laid in culverts are mostly theoretical and disappear in actual work," and "that bare copper mains are inconvenient and unreliable, and expensive in first cost and subsequent maintenance."

THESE STATEMENTS ARE FALSE!!

And in respect of the Crompton "Strip" system of bare mains, we can prove it, and that

THE ADVANTAGES ARE EMINENTLY PRACTICAL.
THEY DO NOT DISAPPEAR IN ACTUAL WORK.
BARE COPPER MAINS LAID ON OUR SYSTEM ARE THE MOST CONVENIENT FOR ALL PURPOSES.
THEY HAVE NEVER FAILED. THEY SAVE IN FIRST COST.
WE GUARANTEE THE COST OF MAINTENANCE TO BE LESS THAN THAT OF ANY INSULATED SYSTEM.

We have never knowingly circulated false statements about other systems of insulated cables; we, therefore, claim unhesitatingly the right to publicly refute the above published statements which might be thought to apply to our bare strip system. 311

Mansion House Buildings, E.C. **CROMPTON & CO., LTD.**

Telegraph Address:— "Ohm, London." **ELLIOTT BROTHERS,** Telephone No. 3,852.

101 & 102, ST. MARTIN'S LANE, LONDON, W.C.

Electrical Engineers and Manufacturers of all kinds of Electrical Testing and Telegraph Instruments.

MAKERS OF

AYRTON & MATHER'S ELECTROSTATIC GRAVITY VOLTMETERS

(As described in the "ELECTRICAL REVIEW," June 9th, 1893).

SOLE MAKERS OF AYRTON & MATHER'S REFLECTING VOLTMETER

(TO 400 VOLTS.)

SOLE MAKERS OF MENGARINI'S REGISTERING VOLTMETER

(As used by the London County Council, City of London Electric Light Co., London Electric Supply Co., &c.)

Highest Award Paris Exhibition, 1889.—Only Grand Prize to any English Electrical Exhibit. 3509

Evidence on Traction and Telephones.—A correspondent points out that in our report of the evidence given by Mr. Jas. Swinburne before the Joint Committee of the Houses of Lords and Commons appears the words "The *earth return* was rarely used on telegraphs . . . ." This was a misprint for "*metallic return*," as our correspondent suggests.

Consulting Electrical Engineer for Kensington.—Major-General C. E. Webber, R.E., has been appointed as consulting electrical engineer to jointly report with the vestry's lighting engineer as to the advisability of the vestry applying for a provisional order for electric lighting purposes in the parish.

Keen Critics.—As a consequence of the price to be charged in Manchester for electric current, one of the public writes to the *Manchester Guardian*, saying that private plants are to be put down. Apparently the writer, amongst others, had written to the Corporation, but had been refused any concession in price equal to what Newcastle-on-Tyne, Preston, or other towns supply at. In the United States, continues the writer, electricity produced from steam power is retailed at much less than Manchester proposes. Is it not time that Manchester should supply gas, electricity, and water under pressure at cheap rates, so as to encourage industries rather than the reverse? The same remarks apply also to quicker locomotion by cable or electrical cars instead of the slowest of slow trams. The public demand is for efficient and cheap services on all these points, and we trust no time will be lost in giving these advantages to the public.

How the Brush Company Strikes a Financial Contemporary.—*Money*, in speaking of the Brush Company, holds forth as follows:—"At a time when one of its rivals, the Electric Construction Corporation, is passing through the waters of tribulation, the Brush Electric and Engineering Company is removing all its plant and the undertaking itself from London to Loughborough, in order to increase its profits and pay still better dividends. But not only so; the Brush Company would no doubt have been well content to remain at Lambeth had it not been that the railway, for extension purposes, required its premises, and were willing to pay a very handsome premium for them. With this premium in hand, and the savings in wages, fuel, &c., consequent upon the removal to Loughborough, in prospect, the position of the company may be considered as very good indeed. The extent of the saving in wages alone may be gauged from the fact that fitters in London who receive 42s. weekly, only expect about 35s. at Loughborough."

A New Alloy Discovered by Electrolysis.—In a recent number of the *Berichte der Deutschen Chemischen Gesellschaft* [xxvi., pages 35—38] there is a paper by T. Poleck upon a new alloy which he has discovered indirectly through electrolysis. Bohemian wolframite, a substance rich in the rare metal tungsten, was subjected to electrolysis, and a mass of metallic alloy composed of iron and tungsten was obtained. This upon subsequent examination was found to consist of a crystalline ground mass of the composition Fe_2, W_3, C_2, in the crevices of which were small crystals of the composition $Fe\,W_2$. The latter form trigonal prisms of the hexagonal system. Both the crystals and the crystalline matrix are silver-grey, very heavy and very hard; in fact, about as hard as corundum, the mineral of which the ruby and sapphire are transparent varieties. (Emery is also a variety of corundum). It has been known for some time that steel alloyed with a small quantity of tungsten acquires extraordinary hardness. Wootz, or Indian steel, contains this substance, whilst electricians are familiar with the fact that a very small addition of tungsten to steel has the remarkable effect of increasing its power of retaining magnetism. Thus a horse-shoe magnet of ordinary steel, weighing 2 lbs., is considered of good quality when it bears seven times its own weight; but according to Siemens, a similar magnet made with steel containing tungsten may be made to carry twenty times its weight suspended from the armature. This new discovery by Poleck appears to suggest a novel, and possible lucrative method of obtaining ferro-tungsten and ferro-carbo-tungsten, and it is to be hoped that this research will not escape notice.

Electric Lighting in Aberdeen.—The proposal of the Aberdeen Town Council to borrow £25,000 for electric lighting purposes has been sanctioned.

Gold Extracting.—The directors of the Universal Gold Extraction Syndicate, Limited, gave an exhibition of the working of their process yesterday. It is an electrical one, and we shall refer to it at length in another issue.

Croydon and the Electric Light.—The Croydon County Council resolved on Monday, subject to the sanction of the Local Government Board, to adopt the electric light in the centre of the borough, at an estimated cost of £25,000.

The Cost of Sleeping at Chicago.—Sleep is, apparently, considered in Chicago a great luxury, and one that must be paid for. Some visitors, to our knowledge, have paid for a small bedroom sums ranging from four dollars to four pounds. A knowledge of these facts will help, no doubt, to assist intending visitors to decide to stop at home. It would be almost cheaper to take an outgoing train from Chicago, in order to sleep.

Electric Lamp Fatality.—On the Piazza Quirinal, Rome, last Thursday evening, says the *Evening Standard*, two electric light lampmen lost their lives through a piece of almost incredible carelessness. One of the large lamps opposite the Palace suddenly went out. The lampman belonging to the district brought a ladder and ascended, but had scarcely touched the carbon when he fell to the ground from a height of some 16 feet. His companion, believing him to be seized with sudden illness, went up in his place, but also immediately fell. Both men had neglected to switch off the current at the base of the lamp. The men were conveyed to the hospital, but they were both dead. The engineer of the society states that the orders given to the men are most rigorous with regard to switching off the current. The King telephoned to the hospital an inquiry about the unfortunate men.

Researches on the Conductivity of Solutions.—The influence of small quantities of non-conducting liquids in modifying the conductivity of other liquids has recently been the subject of an investigation by R. J. Holland. We have already noticed Arrhenius's researches on this subject, and these have been published whilst the present research was in progress, independently. Arrhenius used non-conducting substances which were solvents for the salts contained in the aqueous solutions under examination, but Holland has investigated the effect of non-conducting substances which possess no solvent action on the salts which he employed. These were dissolved in the purest methyl alcohol procurable, all the water being extracted from it by distillation over anhydrous copper sulphate. The degree of dilution of the solutions was from 10 to 100 times as great as that selected by Arrhenius in his research. The salts placed under experiment were the nitrates of potassium, sodium, and lithium, all being pure and carefully dried. The non-conductors were pure benzene, toluene, xylene (which isomer is not stated), and oil of turpentine. Solutions $\frac{1}{100}$, $\frac{1}{1000}$, $\frac{1}{2000}$, of normal strength, were prepared, and 5, 10, 15, 20 per cent. of the non-conductor added. The resistance was measured by means of the Wheatstone bridge and telephone. The results led to the following conclusions, viz.:—1. The conductivity is diminished by the addition of a non-conductor in direct proportion. 2. The diminution in conductivity varies according to the nature of the dissolved salt and the non-conductor. Benzene, toluene xylene, and oil of turpentine diminish the conductivity in the order given, the last-named having the greatest effect. 3. The molecular conductivities may be expressed graphically by straight lines. This investigation is described in full detail in the *Berichte*, xxv., pages 2,726 and 2,727. The author tested some other relations that have previously been observed in the case of aqueous and alcoholic solutions, and found them to hold in this instance, *e.g.*, the increase in conductivity with rise of temperature; the increase of molecular conductivity and the decrease of the temperature with increased dilution.

NEW COMPANIES REGISTERED.

Electro-Magnetic Medical Plaster Company, Limited (39,111).—This company was registered on the 26th ult. with a capital of £10,000 in £1 shares, to enter into a certain agreement, to acquire any inventions for or in relation to electricity, magnetism, or galvanism as medical or curative agent in plasters and other contrivances, and to carry on the business of manufacturers of and dealers in electro-magnetic or other plasters, and of electrical, magnetic, galvanic, chemical, or scientific appliances. The subscribers are :—J. Cunnab, 77, Yarburgh Street, Alexander Road, Moss Side, coal merchant (50); G. C. Elliott, 13, Derby Road, Weaste, retired draper (50); W. J. Henderson, 2, Whitmore Place, Old Trafford, dentist (50); T. Scholfield, 177, Oxford Street, Manchester, restaurant proprietor (50); J. Williams, 77, Alexandra Road, Moss Side, pork butcher (50); H. Mills, 21, Middlewood Street, Harpurhey, manufacturing chemist (1); W. Wise, 101, Piccadilly, Manchester, medical electrician (1). Mr. H. Mills is to be the first manager of the company, at a salary of £200 per annum, and Mr. W. Wise is to be the secretary, at the same remuneration. Registered by T. T. Hill, 22, Chancery Lane, W.C.

Lamina Accumulator (Elieson's British Patents) Syndicate, Limited (39,144).—This company was registered on the 29th ult. with a capital of £12,000 in £1 shares, to enter into an agreement, with or without modification, for the acquisition of the patent rights in Great Britain and Ireland of certain inventions by C. P. Elieson in relation to electric accumulators or storage batteries, and to carry on the business of electricians, electrical and mechanical engineers and suppliers of electricity for the purposes of light, heat, and motive power. The subscribers (with one share each) are :—Earl of Galloway, 17, Upper Grosvenor Street, W.; M. Immisch, 119, Torriano Avenue, N.W., engineer; A. J. Morison, 10, Eastcheap, E.C., merchant; F. D. Schiattinay, 8, Regent Street, W., merchant; L. Goldspink, 5, Thornhill Crescent, N., accountant; A. Bohli, Albion House, Stanisby Road, E., clerk. The first directors are: The Right Hon. the Earl of Galloway (chairman), Alex. J. Morison, M. Immisch, F. A. Pellas, and C. P. Elieson. Remuneration, £3 3s. for the chairman, and £2 2s. for the other directors for each meeting attended. Registered office, 8, Regent Street, W.

Salt Lake and Ogden Gas and Electric Light Company, Limited (39,077).—This company was registered on the 19th inst., with a capital of £300,000, in £1 shares, to carry on in the U.S.A., England, or elsewhere, and particularly in the territory of Utah, U.S.A., the business of a gas and electric lighting company in all its branches, including the manufacture, sale, and supply of gas and electricity for lighting, heating, motive and manufacturing purposes, electrical and heating engineers, and dealers in oils, minerals and vegetables. The subscribers (with 1 share each) are: C. Hanley, 112, Bishopsgate Street, director; J. B. Braithwaite, 27, Austin Friars, stockbroker; C. J. Hamilton, Glenridge, Virginia Water, director; F. H. Leslie, 251, Winchester House, E.C., clerk; F. Sack, Weeping Cross, Stafford, bank director; J. Boustead, 34, Craven Street, W.C., merchant; H. Noel, 17, Westbourne Terrace, W., gentleman. The first directors are to be appointed by the subscribers to the memorandum of association. Remuneration £600 per annum, and percentage of profits, provided the amount so paid does not exceed £1,200.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electric Tramways Construction and Maintenance Company, Limited.—The annual return of this company was filed on May 8th last, and shows that out of a capital of £250,000, in £1 shares, only seven shares (those of the signatories to the memorandum and articles of association) have been taken up. There has been nothing paid.

Manchester House-to-House Electricity Company, Limited.—The annual return of this company was filed on May 8th, and discloses the fact that out of a nominal capital of £100,000, in 19,900 ordinary and 100 founders' shares of £5 each, 107 shares have been taken up. There has been nothing called; but £500 has been agreed to be considered as paid.

Midland House-to-House Electricity Company, Limited.—According to the file at Somerset House, it appears that this company is possessed of a similar capital to the Manchester House-to-House Electricity Company, Limited, and that the same number of shares have been taken up, and have been disposed of in like manner.

Foreign Pilsen Electric Light and Power Company, Limited.—The annual return of this company shows that out of £30,000 in £1 shares, £29,800 has been called and paid.

Indo-European Telegraph Company, Limited.—This company filed its annual return on the 12th ult., which shows that out of a capital of £450,000 in £25 shares, 17,000 have been taken up, with the full amount paid on each. There have been £425,000 remitted, and the amount for which share warrants are outstanding reaches £79,675.

Kensington Court Electric Lighting Company, Limited.—According to a notice filed at Somerset House on the 3rd of last February, an account was laid before the shareholders, showing them the manner in which the winding up of the company has been conducted and the property of the company disposed of.

Electric Stores Company, Limited.—This company has filed its annual return, and from this it appears that out of £15,000, in £1 shares, only the original seven subscribers' shares have been taken up, upon which nothing has been called or paid.

Southampton Electric Light and Power Company, Limited.—The annual return of this company was made on May 8th last, and shows that out of a nominal capital of £30,000, in 4,000 preference and 2,000 ordinary shares of £5 each, 50 preference and 708 ordinary shares have been taken up, with the full amounts paid on each. The total amount of calls received is £3,685, and there is £105 unpaid.

South African Lighting Association, Limited.—It appears from the annual return of this company, filed at Somerset House on the 30th ult., that 3,000 shares of £10 each were taken up. On 2,895 shares the full amounts (£28,950) were called and paid, and the other 105 were issued as fully paid.

London Electric Supply Corporation, Limited.—The annual return of this concern has been made up to 31st ult. Out of a nominal capital of £1,250,000, in £5 shares, 111,000 ordinary and 48,050 preference shares have been taken up. The full amounts have been called, and the sum realised reaches £798,890. There has also been £3,740 paid on 1,950 preference shares, which have been forfeited. The calls unpaid extend to £100.

Reuter's Telegram Company, Limited.—The annual return of this undertaking, made up to the 14th inst., shows that out of a nominal capital of £100,000, in 12,500 of £8 each, 11,839 shares have been taken up. The full sum has been called on these shares, and the amount resulting from this equals £94,712.

Stanhope Company, Limited.—The annual return of this company was made up a short time ago, and shows that out of a nominal capital of £30,000 in £5 shares, the whole number of shares have been taken up, with £5 called upon each. The total amount of calls received is £20,000, and £10,000 has been considered as paid.

Willans & Robinson, Limited.—This company has recently filed its annual return, which shows that 2,214 fully paid, 58 £5 paid, and 11 £25 paid shares have been taken up, out of a capital of £200,000, in £50 shares. There have been 980 shares issued as fully paid. The total amount of payments reaches £62,26

Pyke, Harris & Co., Limited.—The statutory return of this company was filed a short time ago, and shows that out of a nominal capital of £30,000, in 1,400 "A" and 4,600 "B" shares of £5 each, 1,218 "A" and 3,600 "B" shares have been taken up. The "B" shares have been issued as fully paid. The full amounts have been called, and all calls paid, on the other class of shares.

R. C. Cutting Douglas and Company, Limited.—The statutory return of this company has lately been made, and shows that out of a nominal capital of £12,000, in £5 shares, 49 shares have been taken up. On 47 of these £5 has been called; and £2 10s. has been called on the remaining two. The total amount of calls received equals £240.

Railway Automatic Electric Light Syndicate, Limited.—The registered office of this company was changed, on May 1st last, to 37, Walbrook, E.C.

London Electric Manufacturing Company, Limited.—The address of this company is now 50, Old Broad Street, E.C.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bolton Corporation.—The Gas and Lighting Committee are prepared to receive tenders for the supply and erection of alternators and dynamos for the Corporation's electric light station. Specification and form of tender may be obtained from Mr. Rider, borough electrical engineer. Other details will be found in our advertisement columns.

Carshalton.—July 19th. Lighting. For lighting their district, consisting of the entire area of the parish of Carshalton, with gas, oil, or other illuminant, at per lamp, exclusive of the cost of columns, frames, and lanterns, for 12 months from 31st inst., for the Local Board. Tenders, marked "Public Lighting," and addressed to the Chairman of the Board, must be delivered at the Board Offices, High Street, at or before 12 noon on 19th inst. Mr. Charles P. Lovelock, clerk.

City of Jassy.—Tenders wanted for lighting Jassy by electricity. Terms of competition will be forwarded on application to A. Solomonesco, Secretary Administrative Office.

CLOSED.

London, E.C.—For supplying electric lamps above the footways outside the London Central Markets, for the Court of Common Council:—City of London Electric Lighting Company, £598 (accepted).

Portsmouth Mains.—The tender of the International Electric Subway Company, Limited, has been accepted. Details of this will be found in our business notes.

BUSINESS NOTICES, &c.

J. A. Berly's Universal Electrical Directory for 1893 (12th year), 784 pp. This standard work contains a larger amount of trade information than any other similar publication, and should be in the hands of every engineer or electrician. Free within the Postal Union for 4s.

Portsmouth Electric Lighting.—At a meeting of the Town Council on Tuesday, under the presidency of the Mayor (Alderman R. Barnes), a report was submitted by the Electric Lighting Committee, with tenders received for the electric lighting mains and the various fittings and accessories. Eight tenders in all had been received (excluding one that was delivered after the time named). Of these, five provided for armoured cables for high tension mains and arc conductors being laid direct in the ground, and a drawing-in system for all the mains. The tenders gave a fixed price for certain specified work, and a schedule of prices for fittings and accessories. The five tenders providing for armoured cables gave the following fixed prices:—

	£
British Insulated Wire Company	10,344
Silvertown Company	10,385
Callender Company	10,639
Siemens Brothers & Company	10,706
W. T. Henley's Telegraph Works Company ...	10,907

The tenders providing for drawing-in system gave the following fixed prices:—

	£	s.	d.
International Electric Subway Company ...	10,504	0	0
W. T. Glover & Co.	12,465	7	8
Reid Brothers...	12,488	0	0

Adding to these several sums the estimated cost of the fittings and accessories according to the schedule of prices in each tender, the amounts were as follows:—
On the first five tenders:

	£	s.	d.
British Insulated Wire Company	11,673	10	0
Callender Company	12,537	0	0
Silvertown Company	12,712	0	0
Siemens Brothers	13,407	0	0
W. T. Henley's Company	14,579	0	0

On the other three tenders:—

	£	s.	d.
International Electric Subway Company ...	12,043	0	0
W. T. Glover & Co.	15,221	7	8
Reid Brothers	15,244	0	0

After due consideration the committee came to the conclusion that, looking at the small difference in cost, it would be better to provide for a drawing-in system for all the mains, as with this system it would scarcely ever be necessary to re-open the roads or footways after the cables had been once laid. The committee therefore recommended that the tender of the International Electric Subway Company be accepted at the fixed price, but that the committee be authorised to order the fittings and accessories under the contract at their scheduled prices. Under the contract with Messrs. Yates and Thom and S. Z. de Ferranti, Limited, there is a schedule of prices for transformers and other fittings, and the committee recommended that they be authorised to give orders under this schedule to the extent of £3,000. Alderman Ellis, chairman of the committee, announced that the International Electric Subway Company's tender had been altered to £12,000, and their tender, including all accessories, from £12,043 to £13,539. That day the committee had arrived at the last contract for completing the installation entrusted to their care, and notwithstanding the fact that they had procured the best machinery, of the most improved make, and included the cost of the mains, the total amount would be considerably less than the estimated sum.—A Councillor suggested that as the first tender of the International Company was wrong it should be thrown out.—The ex-Mayor (Alderman Scott Foster) said the committee were satisfied that the mistake was unavoidable, a lump sum of £3,000 for excavations having been inadvertently omitted.—The report was adopted.

What Municipal Authorities are Doing.—BOLTON.—The Bolton town authorities do not seem altogether happy with their choice of the alternating current system. On the proceedings of the Gas and Lighting Committee coming up for consideration, a protracted discussion ensued with regard to the proposed electric installation which the corporation propose to lay down in Bolton, and to have working early next year. Alderman Broughton, who formed one of a sub-committee on this question, took exception to the decision of the committee, and observed that had the suggestions of certain people been carried out, the scheme would have cost the town £40,000 or £50,000, instead of half those figures. He expressed his disagreement with the engineer and the committee in regard to the system approved of—the alternating current—and held that the first scheme, to which favourable consideration was given, viz., the continuous current, should have been adhered to, his idea being that, if less cheap, it was more safe than the other. Councillor Finney also saw no adequate reason for the change which had taken place in the opinion of the committee with regard to the two systems. He had an uneasy feeling that justice had not been done to the merits of the continuous current system, and that at the outset the committee had made a slip in not engaging an eminent electrical expert to advise them and lay down the system, his services to be followed by those of a manager who would work out the system. Councillor W. Cooper observed that after lengthened consideration, they had come to the conclusion that they would get all the advantages by the alternating current that they could by the continuous current, and at a less cost—£21,000 for 4,000 16-candle-power lamps, as against £28,935 by the continuous current system. Alderman Miles said the first report agreed upon was only a provisional one, and certainly not final. In regard to the respective merits of the two systems, he pointed out that less tension was needed for the alternating system, the cost of maintenance was less, and the system was a flexible one, and adapted for scattered lighting, which would be needed in Bolton. The alternating current was used in over 30 English towns, so that they were following on well trodden lines. They proposed an initial pressure from the Spa Road station to the first sub-station of 2,000 volts, and a network of supply wires of 100-volt pressure. He considered that there had been no necessity for professional aid beyond that of the electrical engineer engaged, and that time would show that the committee had been fully warranted in the action they had taken. The proceedings were then unanimously confirmed. We commented quite recently on this subject, and congratulated the committee on their choice of the system. We see no reason to alter our opinion.

New List, &c.—We have received the new price list of the Gülcher Company. There is an apparent reduction in the price of dynamos and other apparatus supplied by this company. The list includes for the first time, we believe, transformers, accumulators, measuring instruments, wires, cables and fittings.

We have received from Messrs. Faraday & Sons an advance copy of their illustrated catalogue of electric light fittings for 1893. The designs are novel, and in the best of taste. Certainly some are fashioned in a most curious manner, but they would be nevertheless much admired. The beaded tassle shades, the ivorine flower shades, and the snake convoluted standards are singularly good. Messrs. Faraday make and sell a good many of Sir David Salomons's well-known canting pendents. We may add that the Faraday & Son catalogue is extremely neat and well printed

Electrical Illuminations and the Royal Wedding.—Not alone in London was electricity used as an illuminative effect on the occasion of the Royal Wedding last week, for the Oxford Electric Company, Limited, commemorated this event in a very striking manner. All the arc lamp standards were tastefully decorated with flags, and red, white, and blue bunting. Three arc lamps of 1,200 C.P. each, and two photographic transparencies of the royal pair, were suspended over Carfax, the principal crossing of the city, in addition to the arc lamp which is permanently fixed there, and the effect was very brilliant and much appreciated. The *piece de resistance* of the evening, however, was the powerful search light, which was lent by the Brush Electrical Engineering Company for the occasion, which was fixed upon the roof of the highest house at Carfax. The company had several orders from their consumers for illuminations, windows and signboards being picked out with hundreds of incandescent lamps.

At the Albemarle Hotel, Piccadilly, in conjunction with Messrs. V. & G. Jetley, Messrs. Frank Suter & Co. carried out an illumination which was remarkably effective. Along the front of the building just over the ground floor were arranged five gold statues, each one of which was surrounded by a large arch covered with pink and white may, amongst which pink tinted lamps were dispersed. Two rows of electric lamps, arranged pink and gold alternately, extended across the hotel at intervals of 9 inches. In all 750 lamps were used in these illuminations.

In addition, Messrs. Frank Suter & Co. completed for Messrs. Pears an illumination device, in which they succeeded in securing an artistic effect both by day and night. About 300 electric lamps were used altogether. About 10 arc lamps were fixed over the top of the building.

Cost of Lighting Omnibuses by Electricity.—At the meeting of the Tramways Institute, a few days ago, Mr. Edwin Freund, of the Bristol Electric Safety Lamp Works, read a paper on "Lighting Omnibuses by Electricity." He stated that from the point of view of omnibus lighting, where, say, a 5 C.P. lamp was wanted for six hours at an average, an A A battery, weighing 8 lbs., could discharge fast enough to maintain this light, while 15 or 20 lbs. would have to be carried were another type of battery chosen. The dull lights did not, as a rule, exceed 3 per cent., and such a small number could easily be served with spare lamps. There was, however, not a single case on record where the plates of the battery had suddenly given way, and put the omnibus in darkness. Incandescent lamps could be replaced in one minute, and if spare lamps were kept by the inspectors, or deposited in a few places along the road, failures from this cause could be easily remedied. The expense for current was a very small item, as long as the batteries were regularly used and returned. Repairs, also, did not amount to much, as far as electrical wear and tear were concerned. The only difficulties encountered had been caused by conductors who short-circuited the batteries by putting them face to face, and partly by carelessness in returning the batteries without even strapping them. The first-named stumbling-block had been removed by putting protectors on to the batteries, which made their terminals inaccessible. The second difficulty could easily be overcome by the use of boxes for the collecting of the batteries. The author's estimate for lighting 200 omnibuses for the first year was £775, as first cost, and maintenance £475, or 47s. 6d. per 'bus per year as a minimum. This included ample allowance for repairs.

Elmore's Wire Manufacturing Company, Limited.—Notice is given in the *London Gazette* that a petition for the winding-up of the company by the High Court of Justice, was, on the 7th day of July, 1893, presented to the said Court by Beckett & Co., of 8, Park Row, in the City of Leeds, bankers, creditors of the said company; and that the said petition is directed to be heard before the Court sitting at the Royal Courts of Justice, Strand, London, on Friday, the 21st day of July, 1893; and any creditor or contributory of the said company desirous to support or oppose the making of an order on the said petition, may appear at the time of hearing by himself, or his counsel, for that purpose; and a copy of the petition will be furnished to any creditor or contributory of the said company requiring the same by the undersigned, on payment of the regulated charge for the same:—Patersons, Snow, Bloxam, and Kinder, 25, Lincoln's Inn Fields, London, W.C.; agents for Dibb & Co., Leeds, solicitors for the petitioners. Note.—Any person who intends to appear on the hearing of the said petition must serve on or send by post to the above-named, notice in writing of his intention so to do. The notice must state the name and address of the person, or, if a firm, the name and address of the firm, and must be signed by the person or firm, or his or their solicitor (if any), and must be served, or, if posted, must be sent by post in sufficient time to reach the above-named not later than six o'clock in the afternoon of the 20th of July, 1893.

Town Hall Lighting.—The Town Hall Committee of the Morley Corporation decided on Thursday evening that the new town hall should be lighted with electricity. It also recommended the council to appoint a special committee to report as to the advisability of obtaining powers to supply electricity to private consumers, as well as to use it for street lighting. The Dewsbury and Cleckheaton town halls are lighted by electricity.

Dissolution of Partnership.—From June 24th, Mr. J. Appleton ceased to be a partner of the firm of Appleton, Burbey and Williamson. The business will be carried on as usual, and under the title of Burbey, Williamson & Joseph, by whom outstanding debts, liabilities and assets are taken over.

Willans Engines on American Steamboats.—A Willans engine is coupled to a Lundell dynamo on board a new American steam yacht. The combination is novel from an American point of view, and attracts much attention.

Electrical Measuring Instruments.—We have received from Messrs. Paterson & Cooper a supplementary price list of electrical measuring instruments for direct currents, together with a copy of the tests made to ascertain the effect produced upon them by currents in their proximity. As our readers are aware, in some forms of voltmeters the error due to this cause may be as much as 50 per cent., but in Paterson & Cooper's dead-beat electromagnetic voltmeter the error is practically nothing, the experiments showing that the voltmeter is unaffected by currents in its neighbourhood, except when placed directly over the leads.

Lancaster and the Electric Light.—On Wednesday, Major-General Crozier, R.E., held a Local Government Board inquiry into an application made by the Lancaster Town Council for sanction to borrow £25,000, the estimated cost of a system of electric lighting installation for the borough, to be provided by the Brush Electrical Engineering Company, of London. For the present the Corporation propose to light only the main streets in the centre of the town; but arrangements are being made so that additional plant may be put down as required.

Another Vibration Case.—Mr. Blackie, of 392, Strand, has commenced an action against the Electricity Supply Corporation for damages caused by vibration. It is said that the vibrations are sufficient to make the standard clock of the plaintiff absolutely unreliable. The case is proceeding.

Accrington.—The terms on which the Local Government Board have given sanction for the borrowing of money for electric lighting purposes are not considered satisfactory; the matter will be delayed in consequence.

Blackpool Tramways.—Mr. John Lancaster has been appointed general manager of the electric tramways in place of Mr. J. Hesketh, who will require to give his whole time to superintend the new electric lighting system.

Electrical Firms wanted in Calcutta.—A Calcutta correspondent of *Electrical Plant* says that it would pay a really good firm of electrical engineers to start business in India.

Fire at an Electrical Engineers.—Messrs. Ross and Wilkie, electrical engineers, of Dundee, had a fire early this week, which has destroyed the contents of their premises.

Large Dynamo for the Turks.—The Electric Construction Corporation have supplied a large high-pressure dynamo of 50 ampères, and 2,000 volts, to the Turkish Government.

Complaints at Morecambe.—Residents of Morecambe complain of the noise from the electric light station. The matter has gone before the Local Government Board.

The Financial Results of the World's Fair.—It is computed that the loss to the stockholders of the World's Fair enterprise will be close on six million dollars.

Inspector Wanted at Liverpool.—A trained electrical engineer is wanted by the Corporation to act as electric inspector. Salary, £150 per annum, rising to £170.

Proposed Edinburgh Tramway.—The Caledonian Electric Supply Company have signified their intention of applying for powers to build an electric tramway.

Telephone Company of Ireland.—At the last meeting of this company, the Chairman recommended that the business be sold to the National Company.

Huddersfield Wants Assistance.—Assistant electrical engineer wanted for Huddersfield Corporation. High-tension man preferred. Salary not stated.

Lighting of Bognor.—The London and Lancashire Electric and General Engineering Company intend applying for a provisional order.

American Syndicates.—They are fond of syndicates and corners in America; this time it is to be a great electric traction syndicate.

Rotherham Moves Slowly.—The people of Rotherham are complaining of the delay in introducing the electric light into the town.

Sheffield Lighting.—*Electrical Plant* says that Babcock and Wilcox boilers and Green's economisers are to be used at the new station.

Thomson-Houston Company for France.—A French company has been formed in Paris to work the Thomson-Houston system.

West Ham.—The Town Council want an electrical engineer to prepare plans for carrying out work for the new station. Salary £250.

Municipal Telephones for Glasgow.—The Town Council will apply to the Postmaster-General for a telephone licence.

Turkish Navy.—It is said that experiments are being made to determine the best electrical system for search lights.

Electric Lighting at Worcester.—Mr. Preece will advise for 2½ per cent. on the contract price of the town lighting.

Birmingham Corporation.—The Corporation deem it inadvisable to undertake the supply of electricity.

St. James's and Pall Mall Electric Light Company.—A 7 per cent. interim dividend for the half-year has been declared on the preference shares.

Paper Insulation.—It is said that the City Company are using mains with paper insulation on part of their system.

Works for Sale.—The business of Mr. M'Whirter, lately carried on at Govan and Aberdeen, is for sale.

Street Lighting in Vienna.—It is proposed to light the streets of Vienna with arc lamps.

Newport.—Newport folk think Prof. Robinson's low-tension scheme is too expensive.

CITY NOTES.

National Telephone Company.

THE report of the directors for the year ending April 30th last states that the income accrued amounts to £583,590, as compared with £463,741 for the preceding year, being an increase of £119,849. The rentals carried forward for unexpired terms of running contracts amount to £285,020, as compared with £234,370 for the preceding year, or an increase of £50,650. Working expenses and other charges (excluding debenture and other interest) amount to £311,644, as compared with £236,252 for the preceding year, being an increase of £75,392. The net result, after deducting the Post Office royalties amounting to £54,220, is a profit balance of £217,725, as compared with a balance of £187,250 for the preceding year, being an increase £30,475. Out of the available balance an interim dividend at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the third preference and ordinary shares has already been paid. The board recommend a further payment at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the third preference and ordinary shares, making the dividend for the year 6 per cent. on the first and second preference shares, 5 per cent. on the third preference shares, and 5 per cent. on the ordinary shares. The distribution on the ordinary shares of 1 per cent. less than in the preceding year is recommended by the board chiefly in view of the desirability of strengthening the position of the company by carrying an adequate annual sum to the reserve fund. The board propose, under the articles of association, to transfer to the reserve fund £30,000 (bringing that fund up to £134,627), and to carry forward the balance of £2,194. During the year the purchase has been completeted of the undertakings of the Western Counties and South Wales Company, the Sheffield Company, and several other minor companies, involving the outlay of £345,776, and since the end of the past financial year arrangements have been made for acquiring the Telephone Company of Ireland. The board have had to consider their position in relation to the New Telephone Company, which was launched in avowed competition with the National Company. The promoters of that enterprise soon began to appreciate the serious difficulties which lay before them, and, as the result of discussion, accepted the conclusion that if the shareholders were to be secured a reasonable return upon their capital, it would be better in the public interest to work in harmony with the National Company, adopting, as far as practicable, the better features of the two systems. This resulted in an agreement, under which the National Company subscribed one-third of the capital of the new company, and were represented on the board of that company. Subsequently it became apparent that the policy of the Government, in assuming possession of the trunk wires, forming the inter-town communication of the country, would greatly complicate the position of the licensed companies, and make unity of administration and interest essential to efficiency and success; therefore, upon the sudden death of the late Duke of Marlborough, who was the enthusiastic and moving spirit of the new company, those who were associated with him recognised the necessity of still closer union with the National Company, and matters have ended in the National Company acquiring, partly by purchase, and partly by the exchange of New Company's shares for National shares, nearly the entire interest in the New Company. During the year negotiations of a difficult and complicated character in relation to the acquisition by the Government of the company's trunk lines have been carried on with the authorities of the Post Office. The board are gratified to be able to report that a draft agreement is now in course of preparation, which, it is hoped, may be shortly accepted and ratified by the contracting parties.

Eastern Telegraph Company, Limited.

THE revenue for the half-year amounted to £372,852 10s., from which are deducted £102,499 7s. for the ordinary expenses and £32,532 17s. 11d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £3,263 18s. 8d. for income-tax, there remains a balance of £234,556 6s. 5d., to which is added £62,942 4s. 4d. brought from the preceding half-year, making a total available balance of £297,498 10s. 9d. From this balance there have been paid—interest on debentures and debenture stock, £27,891 0s. 3d.; dividend on preference shares, £20,474 1s. 8d.; an interim dividend of 2s. 6d. per share on the ordinary shares, £50,000—£98,365 1s. 11d.—leaving a balance of £199,133 8s. 10d., from which £88,000 has been carried to general reserve fund. The directors now recommend the declaration of a final dividend for the year ended March 31st, 1893, of 2s. 6d. per share, and a bonus of 3s. per share, amounting together to £110,000, both payable on the 13th inst., free of income-tax, and making, with the three previous payments on account, a total distribution of 13s. per share, or 6½ per cent. for the year, on the ordinary shares.

Sir JOHN PENDER, in presiding at the meeting held yesterday, said that the gross receipts were £372,852, and in analysing the details of accounts stated that there was an increase of about £3,000 from messages. There was a reduction in the traffic at South America and Portugal, but that had been recouped by increases in other directions. The total ordinary expenses for the half-year amounted to £102,499. As the business progressed they had to employ many additional clerks, and increased salaries had to be paid. The result of the year was the distribution of 6½ per cent., and they carried forward £88,000 to the reserve fund, as against £68,000 in the corresponding period of last year. Although the previous half was the best half year's results he had to report, the last showed a still further improvement. Out of the many disasters which occurred the company benefited, for whilst in good times the telegraph system was used throughout the world for commercial purposes, in bad times of accident and disaster the telegraph was made available to help to bring the bad times to an end as quickly as possible. The company was scarcely 25 years old, and it held a position among the companies in London second to none. During all the hard times they had maintained the value of their shares on the Exchange. When the *Victoria* disaster occurred, he found that those on board had many relatives in this country who were exceedingly anxious to know who were saved, and he communicated to Admiral Hoskins to the effect that whatever he thought should be passed over the line free the company would be only too glad to do it, free of all charge. For that the company had been publicly thanked in the House of Lords by Lord Spencer, and he (the chairman) believed the meeting would endorse the action of the board. Before the end of the year he believed they would have completed the arrangement with the Government to connect the Seychelles islands and Mauritius with Zanzibar. Although they had been nearly defeated by a French company, because of its active assistance by the French Government, they had at last succeeded in their negotiations with the Portuguese Government to connect the Azores islands with Lisbon. The chairman concluded by a touching reference to the loss sustained by the company in the death of Sir James Anderson.

The report was adopted.

West African Telegraph Company.

Sir JOHN PENDER, G.C.M.G., M.P., presided over the eighth ordinary general meeting of the above company, held at Winchester House yesterday, and, in moving the adoption of the report, said their gross revenue was £60,922 14s. 2d., an increase over 1891 of £709. The receipts from Portuguese stations showed a large falling off; but there was a large increase in the guarantee from the Portuguese Government. The receipts from the French stations also showed an increase. There had been a loss on the exchange of £8,000, which was chiefly owing to the continued depreciation of Portuguese currency. They had done everything possible to minimise loss, and the Portuguese had agreed to them collecting a higher rate on certain classes of traffic. The total working expenses for 1892 amounted to £2,019, against £2,883 in 1891, or a decrease of £864, the principal decrease being under the heading of expenses in London. The repairs to cables were £13,964, against £2,213, or an increase of £11,751. The work had been carried out by the ships of the East African Company. This large increase was due to breaks which had occurred in the Sao Thomé section, off the River Congo, and after consideration they had decided to divert the cable so as to be beyond the influence of the under currents. This would be a large expense, and under the circumstances they had decided to carry the £2,410 balance forward and declare no dividend. Sir John concluded by expressing the hope that in six months' time he would be able to show a much better case.

The adoption of the report was seconded by Sir HENRY C. MANCE, and carried unanimously.

Sir H. Mance was re-elected a director, and Messrs. Dever, Griffiths and Co., auditors, and the proceedings concluded with a vote of thanks to the chairman.

St. James's and Pall Mall Electric Light Company.—The directors have declared an interim dividend for the half-year ending June 30th, 1893, at the rate of 7 per cent. per annum on the preference shares. The transfer books will be closed from July 14th to July 24th inclusive.

Telegraph Construction and Maintenance Company, Limited.—An interim dividend of 12s. per share has been declared, payable 25th inst.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 9th, 1893, amounted to £1,069; week ending July 10th, 1892, £733; increase £336; total receipts for half-year, 1893, £1,069 corresponding period, 1892, £733; increase £336.

The Western and Brazilian Telegraph Company, Limited. The receipts for t week ending July 7th, after deducting 17 per cent. of the gro receipts payable to the London Platino-Brazilian Telegraph Compan Limited, were £2,372

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation July 4th.	Closing Quotation, July 12th.	Business done during week ended July 12th, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102 xd	99 —102	...	...
1,134,640*l*	Anglo-American Telegraph, Limited	Stock	51 — 52	51 — 52	51	...
2,932,680*l*	Do. do. 6 p. c. Preferred	Stock	94½ — 95½	94 — 95	95½	94½
2,876,140*l*	Do. do. Deferred	Stock	10½ — 11	10 — 10½	10½	...
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜ — 12½xd	11⅜ — 12⅜	12⅜	11⅞
36,400*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ..	100	106 —110 xd	106 —110	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3½	3 — 3½	3	...
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2 3/16	2⅛
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	107 —109	107 —109	107	...
20,510	{ Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000 }	5	5 — 5½	5 — 5½	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000*l*	City and South London Railway	Stock	37 — 39	35 — 37	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11½ — 12	11½ — 11⅝	11 15/16	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12½ — 12⅝	12⅝ — 13½	13 1/16	12
$7,716,000	Commercial Cable, Capital Stock	$100	138 —142	138 —142	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16 — ¼	3/16 — ¼	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 5⅝	5½ — 5⅝	...	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	18½ — 19½	18½ — 19½	19½	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅞ — 12⅛	11⅞ — 12⅛	12 1/16	12
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15½ — 15⅝	15½ — 15⅝	15½	15⅝
70,000	Do. 6 p. c. Preference	10	16½ — 17	16½ — 17	...	...
105,900*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,294,100*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	112 —115	112 —115	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅝ — 16	15⅝ — 16	15 15/16	15 13/16
70,600*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	102 —105 xd	102 —105	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105 xd	102 —105	104	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	113 —116	113 —116	...	...
108,700*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	101 —104 xd	101 —104	...	...
146,800*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104 xd	101 —104	103	102
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	102 —105	102 —105	...	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	1½ — 2	1⅞ — 2⅛	2	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1/16 — ⅛	1/16 — ⅛	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛ — 3/16	3/16 — ⅛	⅛	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅛ — 3/16	3/16 — 3/16	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1 — 2	1 — 2	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅞ — 10	9⅞ — 10	...	...
160,042	Do. do. 6 p. c. Preference	10	15⅝ — 15⅞	15⅝ — 15⅞	15 11/16	15⅝
150,000	Great Northern Tel. Company of Copenhagen	10	19½ — 20 xd	19½ — 20	20	19⅝
200,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ..	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,690*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7 xd	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	23 — 24	23 — 24	23½	23⅝
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 42	39 — 42	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4 5/16 — 4 7/16	4 5/16 — 4 7/16	4 7/16	4 5/16
10,000	Do. do. fully paid	5	6⅝ — 6⅞	6⅝ — 6⅞	6⅞	5⅞
37,548	London Platino-Brasilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	..
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6 — 6½	6½ — 7	6⅞	6⅝
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	1½ — 2½	1½ — 2½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	3 — 4	3 — 4	...	...
458,867	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ — 5	4⅜ — 4⅞	5 1/16	4 1/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14¾ — 15½	14¾ — 15½	15½	15
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14¼ — 14¾	14¼ — 14¾	14⅜	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5⅜ — 5⅝	5⅜ — 5⅝	5 9/16	5⅜
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	110 —115 xd	110 —115	113½	111½
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,451	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/16 — ⅛	1/16 — ⅛	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	99 —102 xd	100 —103	...	...
11,802	Reuter's Limited	8	5 — 6	5 — 6	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7½ — 7⅝	7½ — 7⅝	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅞ — 8¼	7⅞ — 8¼	...	...
3,381	Submarine Cables Trust	Cert.	120 —125	120 —125	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	1⅞ — 2⅛	1⅞ — 2⅛	2 3/16	2⅛
37,350	Telegraph Construction and Maintenance, Limited	12	34 — 36	34 — 36	34½	34¼
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104 xd	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	2½ — 3	2½ — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100 xd	90 — 100	...	..
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ — 6½	5½ — 6½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	...	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	99 —103 xd	99 —103	...	...
64,242	Western and Brasilian Telegraph, Limited	15	7¼ — 7⅝	7¼ — 7⅝	7⅝	7¼
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	...	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1½ — 2	1½ — 2	1 3/16	...
178,200*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 —109	...	...
222,700*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	...	..
88,321	West India and Panama Telegraph, Limited	10	1½ — 1⅝	1½ — 1⅝	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10½ — 11	10½ — 11	10 15/16	10⅞
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9½ — 10½	9½ — 10½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —108 xd	105 —108	107½	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
169,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —105	...	...
99,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½ — 5⅝	5½ — 3⅝	5 7/16	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¾—6.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—House to House Company (£5 paid) 1¾—2¼.—Do. 7 per cent. Preference of £5, 5—5¼.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5½—6⅜, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6⅜.—Manchester Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating 6 per cent. £10 Debentures, 101—103.

Bank rate of discount, 2½ per cent (June 15th, 1893).

ROYAL SOCIETY EXHIBITS.

THE summer *conversazione* of the Royal Society was held last month at Burlington House. The exhibition of recent science was fairly representative, but there was nothing of a very startling nature on view. The heroes of the hour were certainly Messrs. A. D. McCormick and W. M. Conway, whose experiences during the Karakoram mountain survey expedition were graphically hinted at by an array of water-colour drawings and photographs. These Kashmir mountains are probably the highest group in the world, the Pioneer Peak being 22,500 feet above sea level. The photographs of glaciers, and the sketches of these impossible altitudes, called for a large share of praise, for it was felt that here, indeed, art and science had reached their most exalted limits.

Mr. A. A. C. Swinton again showed high-frequency experiments. It was specially interesting to note the electric discharge in water. A deep metal dish was filled with water, and was connected to one of the spark terminals of his induction coil. The second terminal was connected to a stout wire, the end of which dipped vertically into the water at the middle of the dish. On passing a discharge through this central wire the water fell away from it with much bubbling. If the wire was now drawn just out of the water an octopus discharge was observed. This last effect was more marked when resin oil was substituted for the water.

The hydrophone of Captain McEvoy was rather a feature at this exhibition. It is essentially a deep-sea microphone, of special sensitiveness, for giving warning of the approach of ships. The microphone is metallic, consisting of a light steel spring and a special platinum contact-piece. This is sunk in the sea, protected by a heavy casing of iron, and is connected to the shore by a cable. It is said to give warning of the approach of mischief in plenty of time to avoid it. The receiving instrument may be an ordinary telephone, or a delicate relay for flashing signals, &c. The apparatus may also be used to warn vessels off dangerous points of the coast. We can only hope that it could be depended upon.

Dr. John Gorham, M.R.C.S., has introduced several improvements in the kaleidoscope, for the purpose of making it more serviceable both as an optical instrument and as an aid to designers of patterns. The principal innovation consists in illuminating the object by reflection, instead of by transmitted light. This is attained by removing a portion of the kaleidoscope tube, so as to admit the light upon the two mirrors from the side, instead of the end of the instrument. By thus throwing the instrument open, the amount of light by which the objects are illuminated is increased, and many novel effects can be obtained. By suitable disposition of objects, the various depths of gray tones are obtained from oblique white surfaces, and much is to be learnt by this means of the tints and shades, the intensity and brilliancy of coloured surfaces. Lustre, which is something between brilliancy and softness of tone, may be reproduced by illuminating a coloured surface, and observing it by reflection from the mirrors. This instrument of Dr. Gorham should recommend itself to all who are interested in the development and harmonising of colours, and the choice of tints and shades.

The next exhibit was also an optical one, and was intended to illustrate Prof. Michelson's method of producing interference bands. For this purpose Mr. Edwin Edser directs a beam of light upon a thinly silvered mirror, set at 45° to the direction of the beam, so that about half the light is reflected, and half transmitted. The two rays thus divided at right angles to one another, are reflected back along a common axis by two ordinary mirrors, and, on meeting, interfere. The coloured image is received on a screen in the usual way. A very curious effect was produced by interposing a smouldering match at a point in the course of one of the rays, a remarkable alteration taking place in the shape of the image. No special slit is required for this experiment. The simplicity of the whole apparatus makes it very suitable for lecture illustration.

Sir David Salomons, Bart., and Mr. L. Pyke had some high-tension experiments to show the various degrees of illumination produced in vacuum tubes under various conditions of exhaustion and inductive influence. These effects were very beautiful. In addition, the curious phenomenon of attraction between two vacuum tubes, one connected to the discharge apparatus, and the other simply acted upon by induction from the first tube, was strikingly observed. The attraction was as marked as though the two tubes had contained steel magnets of moderate strength.

Specimens of submarine borers, and examples of the work they perform upon submarine cables, were exhibited by Mr. W. H. Preece. It was a pity that the Marine Biological Association, who also were exhibiting, did not join forces with Mr. Preece, so as to make the collection more complete.

Examples of electrolytic copper, deposited bright, were shown by Mr. J. W. Swan. This result is attained by the addition of certain quantities of gelatine in the acid solution of sulphate of copper, constituting the electrolyte. The deposits produced in this way, instead of being of the usual dull surface, are not only bright, but they are also very much harder and more elastic than ordinary electrolytic copper.

Prof. Henrici, F.R.S., exhibited a harmonic analyser, constructed according to his designs and those of Mr. Sharpe, for the purpose of giving the first five terms of a Fourier's series upon going once over a curve; and, on going twice more over the curve, to give five additional terms. These are mapped out as a series of sine curves on a separate paper. The constant term is not given.

The lantern stereoscope, an invention of Mr. John Anderton, was demonstrated by Mr. W. Bayley Marshall. The problem here to be solved was to throw upon a screen a pair of ordinary stereoscopic pictures in such a way that the left eye could only see one of them, while the right eye could only see the other. This is accomplished by Mr. Anderton by polarising the two sets of rays, while the observer views them through a two-eyed analyser, one set at right angles to the other, thus only one picture is seen by each eye. The remarkable feature of this invention is that it shows how subtle is the mechanism which regulates single vision. With the unaided eye two flat pictures are seen, superimposed upon the screen; if, now, one of the lantern slides is put a little out of position, the two images are blurred and "fluffy," and a four-footed animal appears as an octopod, a man becoming a quadruped. But when this hopeless confusion is viewed through the analyser all these little defects vanish, and we have a clear, bold picture of great depth and tone. The eye is its own adapter. If the head is swayed from left to right while examining these pictures, the objects take an almost life-like motion. Some curious results may, however, arise when this experiment is performed in too dark a room. A "bobbing" distance of at least 4 feet is recommended between each observer.

TELEGRAPHIC COMMUNICATION IN THE WEST INDIES.

How Trade and Intercourse may most Successfully be Restricted within the Narrowest Limits.

BY DR. R. B. ANDERSON.

(*Concluded from page* 685.)

THERE are so many considerations of importance dealt with in, or arising out of, Mr. Henniker Heaton's article in the *Contemporary Review* of April last, that I do not think, to the electrical world, any apology can be needed for a further review of them.

It is not that Mr. Heaton's objects are obscure, or that their value can be overestimated or overstated. On the other hand they are so very important that any possible obstacle raised by erroneous propositions would be a great misfortune, and that the common necessity of arriving at his goal confers a privilege, and indeed makes it a duty imposed by prudence, to examine critically every step of the projected route.

If it be fair, contrary to Mr. Heaton's view, that large business should pay reduced rates, it is no less true that some business of very occasional occurrence, such as a declaration of war, the breaking out of a rebellion, or causes threatening interruption of friendly relations between powers, is of so great importance that we might almost say that for that alone the expense of laying and maintaining a cable would be well incurred; and there is, on the other hand, news that is of some interest to great numbers of people, but that would or could be transmitted only at a very low rate per word, like much telegraphic correspondence of newspapers, and certainly it is not for this class that cables would be laid, nor probably for any items of communication of a private nature. It is between these classes of news, of which commercial information is the most important of any large class, that the medium will be. And whether the cable were laid by the State to provide for necessities of the first class, or by combinations of commercial interests to provide for necessities of the last class, the capital and working expenses have to be provided and borne; and even if, as by the State, it were provided out of existing funds, the interest that would be otherwise earned would have to be foregone. And the distinction between capital borrowed by the State for such an enterprise and capital invested by private individuals is, that the State gives security totally independent of the success of the enterprise, and can borrow cheap, whilst the private investor—Sir John Pender and his fellow sinners in Mr. Heaton's idea—must, and will, if they are wise, be paid in proportion to the estimation of the risk of loss which they incur.

This risk the State has in almost every case left, in the first instance, to private speculators—to Sir John Pender, or whomsoever it may be, even the West Indian Cable Company, the willing "Puck," who anxiously divines the wishes of his employer, the world at large, and ventures sometimes his all on the issue whether he has divined aright. And it is but just that, buying the resulting and dearly won experience, the State should pay not only the capital, but the value of the risk run, taken at its value, before the result was known, and when the State would not venture to take the risk, and had not the courage to profit by the invention; but yet taken at the value the enterprise has achieved.

And in his ideal conditions, would Mr. Heaton adopt, as his tariff, those rates however low, or even, as might be the case if the whole community bore the cost, no charge at all, but free telegraphy; at which his cables would find full occupation each way from morning till night and from night till morning; or would he adopt that rate which would—ascertaining by trial—bring in the largest returns in money value? He appears to discard this latter criterion, yet it has elements of interest. As between the following conditions:—20,000 words each way at 1s. per word; 40,000—that is, full use of the line—at 3d. per word, often causing much inconvenience of delay to important messages, awaiting their turn for many hours, and 120,000 words each way at 1d., competing as to which 40,000 should be sent and which 80,000 be left unsent; he would, if he were the operator or manager to decide, be glad of a discriminating tariff. It is such a tariff which we should wish to ascertain, and although the problem may be too complex for offhand solution, and although time and opposing interests and forces may be its best solvents, of which forces Mr. Heaton certainly intends to be a plus quantity, yet it

will possibly be found to some extent in an *optional* tariff for more or less immediate transmission.

In the meantime a company may well say in effect to a government, "We cannot tell in advance what use of us you will require, nor, at any given rate, what we shall earn from you; and we seek, instead of rates varying inversely as the quantity of business, a fixed subsidy for a term of years." This is in effect the principle on which subsidies are granted, and we must not forget that the principle is conceded not only by Colonial Governments, but in several instances by the Imperial Government, and that what practically remains to be done, is in all suitable cases, to secure its application. The subsidies may be granted to secure merely the existence of the means of communication, as *e.g.*, that to the Halifax and Bermuda Cable Company on their line to Bermuda, or they may be granted like those of the West Indian Colonies to the Panama Company, to include more or less of all necessary political news, and news of general and public interest; being accepted in this case as the criterion of value of that share of the work to be done, and leaving the private communication either at fixed rates or subject to the judgment or caprice of the promoter, or investor, or company, to make up the difference, and result in the annual gain or loss. And still, as to this portion of the venture, we necessarily revert to the predicated formula—that the rate to be ascertained in the interest of the company is that which will bring the largest earnings—in the interest of the public, that which will, by cheapening the rates, give the greatest increase of traffic. In this the policy becomes a question not only of opinion, but of correctness of judgment. It is natural that all who desire to send messages, and have to pay for them, should think that lowered rates will bring at least equal returns, and, having all to gain and nothing to lose, should contemplate even measures of coercion, as against those who, to them, like Sir John Pender to Mr. Heaton, appear to stand as "sinister angels." It is equally natural that the "sinister angels," having much to lose, should realise very clearly that sometimes, or for some time, lowered rates mean lowered dividends, and to some extent experience bears them out. I have before me reports for several half years of the Eastern Extension, Australasian and China Telegraph Company, Limited, as well as Mr. Heaton's figures in the *Contemporary Review*. There had been a remarkable and steady growth for 10 years of the business of this company, between Europe and Australia, from 26,000 messages, at a cost of £181,480 in 1890, to 67,000 messages at a cost of £331,468 in 1890, an addition, roughly, of 20,000 messages, and £75,000 each five years, or of 4,000 messages at £15,000 per annum. In the year 1891, however, when the Australian rates were lowered from about 9s. to 4s. per word, the messages increased from 67,000 to, not 140,000, as would have been necessary to make good the returns, but only to 80,000; and the earnings, instead of rising £15,000, fell about £46,000, or really, including the loss of the normal increment, they fell £60,000.

I do not find Mr. Heaton's figures correspond precisely with those given in the report of the company for the last half of 1891, the falling off being stated in that report at £55,000 for the eleven months to December 31st, 1891, whilst the increase given (in the number of *words* instead of the number of messages) is stated at 48 per cent. over the corresponding period for 1890, and at 60 per cent. over the corresponding period for 1889. This comparison of words is a better guide than that of messages, and it shows, as might be expected, that not only are more messages sent, but that the messages are longer. I must here revert to what I have said before, that, *ceteris paribus*, in calculations based on ordinary business motives, to justify a reduction of rates to half, a business of more than double should be the result. In this instance, less than half that increase has as yet resulted, causing a loss of actual earnings of the cables. If this loss and the diminishing loss of the next two or three years is to be made up, it can only be by an increase to considerably *over* double the work to be done in later years. And this again is matter for speculation and judgment, and to rely upon such a prevision means risk. It is true that the colonies have borne half the loss; but the remarkable aspect is here introduced of the colonies, which at first urged and encouraged the reduction, shrinking back at the failure, and themselves, and *not* Sir John Pender, originating a movement to slightly raise the rates (4s. to 4s. 9d.).

This is a second instance of governments wanting the courage of their own opinions, that must characterise the private speculator.

A remarkable feature of the company's reports is, that no dissatisfaction is expressed at this loss, incurred, as I understand, entirely at the instance of the respective colonies. But capitalists do not lose revenue or see dividends diminish without dissatisfaction, unless there be some corresponding advantage. It may be that Sir John Pender sees in the distance the years coming to re-imburse the loss, by greatly increased earnings; or, it may be, that he considers £22,250 for 1891, and some few thousand more in diminishing ratio, for a few years to come well invested, in convincing our enterprising Australian fellow-subjects that if not getting immediately all they want, they were, as they easily could, to lay down competing cables, it is *not quite* so certain as they had supposed that the business to be done at keen competition, or fighting rates, might at once, or even in a time that could be awaited with complacency, be sufficient to make the game worth the candle; or, in other words, that

> Sir John
> Looks on
> With complacent smile,
> And says to Australia,
> By all means avail ye
> Of this experience yet awhile.

And if this be the explanation of the complacency of the company, that part of Mr. Heaton's epigram, and my unepigrammatic proposition, is demonstrated, that it was to wholesome fear of powerful, even though rash competition, that this very great reduction of rates was conceded; and from the point of view afforded by that isolated and unorganised corner of the world, the West Indies, I cannot but look with admiration, not unmixed with envy, at the power of the young giant, whose very aspect, and known strength of will and purpose, probably unexpressed in words, could so compel the company to reason and concession. There seems to be in regard to the relations of the Eastern Extension Company, and the districts they serve, no attempt to affirm any privilege against the encouragement of competition, or any exclusive rights. The whole position seems to be, as, indeed, Mr. Heaton implies, that the fear of invoking competition really exercises a strong influence, and the people and the governments of those places are admittedly in possession, I presume, by lapse of time, and termination of patents and of contracts, of all those benefits which successive inventors and assignees have held and transferred, yet which were, as I have said, by no means a heritage or natural right in the first instance

And so the struggle for better terms on either part to maintain a high tariff, or to secure a reduction, goes on under favourable circumstances, and the difference is still as to what rates will pay the best—the present high rates or rates lowered less or more even down to 6d. to India, and 1s. to Australia, which Mr. Heaton considers would return double the amount yielded by the present rate.

And that struggle, far from being ground of complaint or regret, or of legitimate reproach to the companies, is the most healthy and natural condition, at least until Mr. Heaton can persuade the respective governments to adopt his opinion, and to have the courage of their own convictions, and by guaranteeing the companies their present returns, or if necessary, by laying their own cables, secure a trial, whether a one shilling rate would be as productive as Mr. Heaton believes, affording a return double that given by the present rate of 4s. per word, or £2,000 per day, instead of, as now, £1,000.

In the West Indies hitherto, there has been no possibility, no hope, on the one hand, and no fear on the other hand, of competition; and every difficulty and every disadvantage that has operated in the East for a month or a year to delay improvements, is as strong in the West Indies now as it was when the cables were first laid down. And every argument that is urged without effect in the East to arrest progress and improvement, is of three-fold efficacy in the West Indies.

One undoubtedly strong factor on the side of present high tariffs to those colonies is a doubt that results from the loud complaints of the W. I. and Panama Telegraph Company, that to deprive them of their subsidies, or to insist upon reduced rates, would be contrary to good faith; would, in fact be, as under some conditions I have admitted that it might be, an act of confiscation. And this claim, partly from the energy with which it is made, but partly from there having been no means of actively contesting it, or of securing any alternative service, has come in many of the colonies of the West Indies to be regarded as a valid claim.

Yet it would almost appear—I hope I am not misled in supposing so—that a great opportunity is within the reach of the West Indies in securing competition, as against the present high and prohibitive tariffs, or, at least, of making use of the fact that competition may be available to secure far better rates and conditions than the very hard ones under which they now languish. I refer to the offer of the Halifax and Bermuda Cable Company to extend their line, which already connects Halifax and Bermuda to Jamaica, and to establish a 2s. rate from Jamaica to Halifax, 3s. from Jamaica to England, as against the present prohibitive rate of 4s. 7d. and 5s. 7d., respectively.

I have in the present article supplemented the principles I laid down in my former by further considerations derived from experience of telegraphic communication in other countries, chiefly the East, and from the very critical and valuable article of Mr. Henniker Heaton. Yet I do not think that any great variation has followed from the original considerations. The West India and Panama Telegraphic Company has had a monopoly for 20 years, and it remains to show that they have in some respects exhausted, in other respects forfeited, the undoubted equity they at first possessed, of a lengthened period of undisturbed possession in which to enjoy the fruit of their labours and their adventure; that if they have not reaped a satisfactory or sufficient harvest the fault is greatly their own, and that Sir John Pender's dictum in his reply to a deputation of West African merchants, that the black and coloured races have done little for ocean telegraphy, does not apply to the West Indies.

And as I have demonstrated with regard to Tobago, I believe I could demonstrate with regard to the West Indies as a whole, that not only the Imperial Post Office in the interests of trade and commerce and the nation at large, but the War Office and the Admiralty also have connections with those colonies and with Imperial interests there that constitute valid reasons for assisting substantially the improvement and nationalisation of the means of communication with them.

On this subject, the Council of the British and West Indian Alliance, on 19th ult., on the motion of General Graham, passed the following resolution unanimously:—

"That the branches of the West Indian Union be invited to approach the Legislative Councils and Assemblies of the respective colonies, and request them to unite in addressing the Colonial Office in favour of an Imperial subsidy to enable the Halifax and Bermuda Cable Company to extend their cable to the West Indies; or of such other steps as may have the effect of reducing the present prohibitive tariffs, due regard being had to the great desirability that a complete line of communication should be established entirely within the Empire, and not at any point subject to the control of a foreign State."

There can be no doubt that as soon as the Governments of the West Indies realise that they have an opportunity to greatly improve the present hard conditions of communication, they will, with all precautions to secure future proper advantages, make haste to avail themselves of it.

ON LIGHT AND OTHER HIGH FREQUENCY PHENOMENA.*

By NIKOLA TESLA.

(*Continued from page 24.*)

When the frequencies are very high it has been found in laboratory practice quite easy to regulate the effects in the manner shown in diagram, fig. 17. Here two primaries, P and P, are shown, each connected with one of its ends to the line, L, and with the other end to the condenser plates, C and C^1, respectively. Near these are placed other condenser plates, C_1 and $C^1{}_1$, the former being connected to the line, L, and the latter to an insulated larger plate, P_2. On the primaries are wound secondaries, S and S_1, of coarse wire, connected to the devices, *m* and *d*, respectively. By varying the distances of the condenser plates, C and C^1, and C_1, and $C_1{}^1$, the currents through the secondaries, S and S_1, are varied in intensity. The curious feature is the great sensitiveness, the slightest change in the distance of the

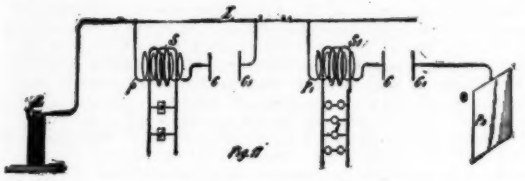


Fig. 17

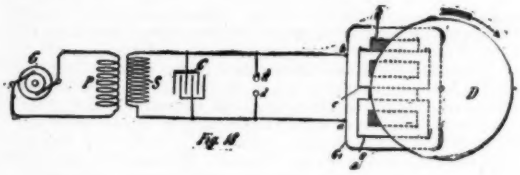


Fig. 18

plates producing considerable variations in the intensity or strength of the currents. The sensitiveness may be rendered extreme by making the frequency such that the primary itself without any plate attached to its free end satisfies, in conjunction with the closed secondary, the condition of resonance. In such condition an extremely small change in the capacity of the free terminal produces great variations. For instance, I have been able to adjust the conditions so that the mere approach of a person to the coil produces a considerable change in the brightness of the lamps attached to the secondary. Such observations and experiments possess, of course, at present, chiefly scientific interest, but they may soon become of practical importance.

Very high frequencies are, of course, not practicable with motors, on account of the necessity of employing iron cores. But one may use sudden discharges of low frequency, and thus obtain certain advantages of high frequency currents without rendering the iron core entirely incapable of following the changes, and without entailing a very great expenditure of energy in the core. I have found it quite practicable to operate with such low frequency disruptive discharges of condensers, alternating current motors. A certain class of such motors which I advanced a few years ago, which contain closed secondary circuits, will rotate quite vigorously when the discharges are directed through the exciting coils. One reason that such a motor operates so well with these discharges is that the difference of phase between the primary and secondary currents is 90°, which is generally not the case with harmonically rising and falling currents of low frequency. It might not be without interest to show an experiment with a simple motor of this kind, inasmuch as it is commonly thought that disruptive discharges are unsuitable for such purposes. The motor is illustrated in fig. 18. It comprises a rather large iron core, *i*, with slots on the top into which are embedded thick copper washers, *c*, *c*. In proximity to the core is a freely movable metal disc, D. The core is provided with a primary exciting coil, C, the ends, *a* and *b*, of which are connected to the terminals of the secondary, S, of an ordinary transformer, the primary, P, of the latter being connected to an alternating distribution circuit or generator, G, of low or moderate frequency. The terminals of the secondary, S, are attached to a condenser, C, which discharges through an air gap, *d*, *d*, which may be placed in series or shunt to the coil, C. When the conditions are properly chosen the disc, D, rotates with considerable effort, and the iron core, *i*, does not get very perceptibly hot. With currents from a high frequency alternator, on the contrary, the core gets rapidly hot, and the disc rotates with a much smaller effort. To perform the experiment properly, it should be first ascertained that the disc, D, is not set in rotation when the discharge is not occurring at *d*, *d*. It is preferable to use a large iron core and a condenser of large capacity, so as to bring the superimposed quicker oscillation to a very low pitch, or to do away with it entirely. By observing certain elementary rules I have also found it practicable to operate ordinary series or shunt direct current motors with such disruptive discharges, and this can be done with or without a return wire.

* A lecture delivered before the Franklin Institute, at Philadelphia, February 24th, 1893, and before the National Electric Light Association, at St. Louis, Mo., March 1st, 1893.

Among the various current phenomena observed, perhaps the most interesting are those of impedance presented by conductors to currents varying at a rapid rate. In my first paper before the American Institute of Electrical Engineers, I have described a few striking observations of this kind. Thus I showed that when such currents or sudden discharges are passed through a thick metal bar there may be points at the bar only a few inches apart, which have a sufficient potential difference between them to maintain at bright incandescence an ordinary filament lamp. I have also described the curious behaviour of rarefied gas surrounding a conductor to such sudden rushes of current. These phenomena have been since more carefully studied and one or two novel experiments of this kind are deemed of sufficient interest to be described here.

With reference to fig. 19*a*, B and B_1, are very stout copper bars connected at their lower ends to plates, C and C_1, respectively, of a condenser, the opposite plates of the latter being connected to the terminals of

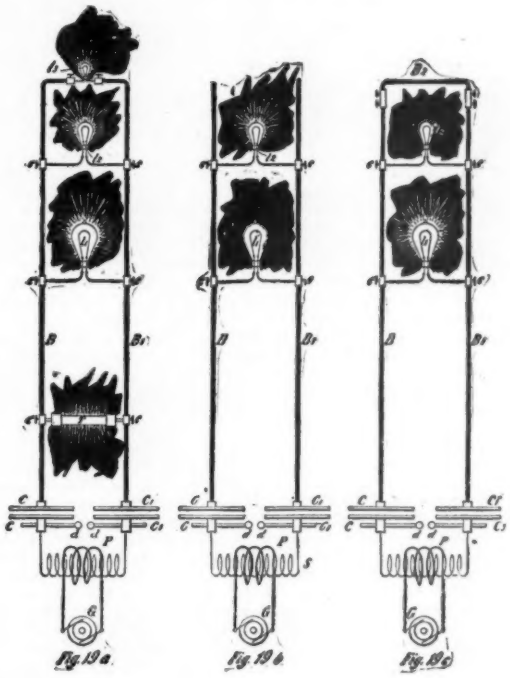


Fig. 19a Fig. 19b Fig. 19c

the secondary, S, of a high-tension transformer, the primary, P, of which is supplied with alternating currents from an ordinary low-frequency dynamo, G, or distribution circuit. The condenser discharges through an adjustible gap, *d*, *d*, as usual. By establishing a rapid vibration it was found quite easy to perform the following curious experiment. The bars, B and B_1, were joined at the top by a low-voltage lamp, l_3; a little lower, was placed by means of clamps, *c*, *c*, a 50-volt lamp, l_2, and still lower, another 100-volt lamp, l_1, and finally, at a certain distance below the latter lamp an exhausted tube, T. By carefully determining the positions of these devices it was found practicable to maintain them all at their proper illuminating power. Yet they were all connected in multiple arc to the two stout copper bars and required widely different pressures. This experiment requires, of course, some time for adjustment, but is quite easily performed.

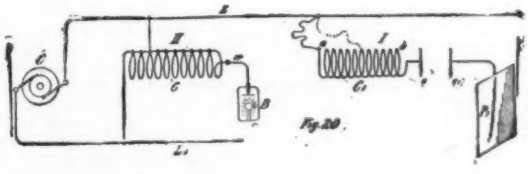


Fig. 20.

In figs. 19*b* and 19*c*, two other experiments are illustrated which, unlike the previous experiment, do not require very careful adjustment. In fig. 20*b*, two lamps, l_1 and l_2, the former a 100-volt and the latter a 50-volt, are placed in certain positions as indicated, the 100-volt lamp being below the 50-volt lamp. When the arc is playing at, *d*, *d*, and the sudden discharges passed through the bars, B, B, the 50-volt lamp will, as a rule, burn brightly, or at least this result is easily secured, while the 100-volt lamp will burn very low or remain quite dark, fig. 19*b*. Now the bars, B, B, may be joined at the top by a thick cross bar, B_2, and it is quite easy to maintain the 100-volt lamp at full candle-power while the 50-volt lamp remains dark, fig. 19*c*. These results, as I have pointed out previously, should not be considered to be due exactly to frequency, but rather to the time rate of change, which may be great even with low frequencies. A great many other results of the same kind, equally interesting, especially to those who are only used to manipulate steady currents, may be obtained, and they afford precious clues in investigating the nature of electric currents.

In the preceding experiments I have already had occasion to show some light phenomena, and it would be now proper to study these in particular; but to make this investigation more complete, I think it necessary to first make a few remarks on the subject of electrical resonance, which has to be always observed in carrying out these experiments.

ON ELECTRICAL RESONANCE.

The effects of resonance are being more and more noted by engineers, and are becoming of great importance in the practical operation of apparatus of all kinds with alternating currents. A few general remarks may therefore be made concerning these effects. It is clear that, if we succeed in employing the effects of resonance practically in the operation of electric devices, the return wire will, as a matter of course, become unnecessary, for the electric vibration may be conveyed with one wire just as well, and sometimes even better, than with two. The question first to answer is, then, whether pure resonance effects are producible? Theory and experiment both show that such is impossible in Nature, for as the oscillation becomes more and more vigorous, the losses in the vibrating bodies and environing media rapidly increase, and necessarily check the vibration which otherwise would go on increasing for ever. It is a fortunate circumstance that pure resonance is not producible, for if it were there is no telling what dangers might not lie in wait for the innocent experimenter. But to a certain degree resonance is producible, the magnitude of the effects being limited by the imperfect conductivity and imperfect elasticity of the media, or, generally stated, by frictional losses. The smaller these losses, the more striking are the effects. The same is the case in mechanical vibration. A stout steel bar may be set in vibration by drops of water falling upon it at proper intervals; and with glass, which is more perfectly elastic, the resonance effect is still more remarkable, for a goblet may be burst by singing into it a note of the proper pitch. The electrical resonance is the more perfectly attained the smaller the resistance or the impedance of the conducting path and the more perfect the dielectric. In a Leyden jar discharging through a short stranded cable of thin wires these requirements are probably best fulfilled, and the resonance effects are therefore very prominent. Such is not the case with dynamo machines, transformers and their circuits, or with commercial apparatus in general in which the presence of iron cores complicates, or renders impossible, the action. In regard to Leyden jars, with which resonance effects are frequently demonstrated, I would say that the effects observed are often *attributed*, but are seldom *due*, to true resonance, for an error is quite easily made in this respect. This may be undoubtedly demonstrated by the following experiment. Take, for instance, two large insulated metallic plates or spheres which I shall designate A and B, place them at a certain small distance apart and charge them from a frictional or influence machine to a potential so high that just a slight increase of the difference of potential between them will cause the small air or insulating space to break down. This is easily reached by making a few preliminary trials. If now another plate—fastened on an insulating handle and connected by a wire to one of the terminals of a high tension secondary of an induction coil, which is maintained in action by an alternator (preferably high frequency)—is approached to one of the charged bodies, A or B, so as to be nearer to either one of them, the discharge will invariably occur between them; at least it will, if the potential of the coil in connection with the plate is sufficiently high. But the explanation of this will soon be found in the fact that the approached plate acts inductively upon the bodies, A and B, and causes a spark to pass between them. When this spark occurs, the charges, which were previously imparted to these bodies from the influence machine, must needs be lost, since the bodies are brought in electrical connection through the arc formed. Now this arc is formed whether there be resonance or not. But even if the spark would not be produced, still there is an alternating E.M.F. set up between the bodies when the plate is brought near one of them; therefore the approach of the plate, if it *does* not always, actually, will, at any rate, *tend*, to break down the air space by inductive action. Instead of the spheres or plates, A and B, we may take the coatings of a Leyden jar with the same result, and in place of the machine, which is a high frequency alternator preferably, because it is more suitable for the experiment and also for the argument, we may take another Leyden jar or battery of jars. When such jars are discharging through a circuit of low resistance the same is traversed by currents of very high frequency. The plate may now be connected to one of the coatings of the second jar, and when it is brought near to the first jar just previously charged to a high potential from an influence machine, the result is the same as before, and the first jar will discharge through a small air space upon the second being caused to discharge. But both jars and their circuits need not be tuned any closer than a basso profundo is to the note produced by a mosquito, as small sparks will be produced through the air space, or at least the latter will be considerably more strained owing to the setting up of an alternating E.M.F. by induction, which takes place when one of the jars begin to discharge. Again, another error of a similar nature is quite easily made. If the circuits of the two jars are run parallel and close together, and the experiment has been performed of discharging one by the other, and now a coil of wire be added to one of the circuits whereupon the experiment does not succeed, the conclusion that this is due to the fact that the circuits are now not tuned, would be far from being safe. For the two circuits act as condenser coatings and the addition of the coil to one of them is equivalent to bridging them, at the point where the coil is placed, by a small condenser, and the effect of the latter might be to prevent the spark from jumping through the discharge space by diminishing the alternating E.M.F. acting across the same. All these remarks, and many more which might be added but for fear of wandering too far from the subject, are made with the pardonable intention of cautioning the unsuspecting student, who might gain an entirely unwarranted opinion of his skill when seeing every experiment succeed; but they are in no way thrust upon the experienced as novel observations.

In order to make reliable observations of electric resonance effects, it is very desirable, if not necessary, to employ an alternator giving currents which rise and fall harmonically, as in working with make and break currents the observations are not always trustworthy, since many phenomena, which depend on the rate of change, may be produced with frequencies widely different. Even when making such observations with an alternator one is apt to be mistaken. When a circuit is connected to an alternator there are an infinite number of values for capacity and self-induction which, in conjunction, will satisfy the condition of resonance. So there are in mechanics an infinite number of tuning forks which will respond to a note of a certain pitch, or loaded springs which have a definite period of vibration. But the resonance will be most perfectly attained in that case in which the motion is effected with the greatest freedom. Now, in mechanics, considering the vibration in the common medium—that is, air—it is of comparatively little importance whether one tuning fork be somewhat larger than another, because the losses in the air are not very considerable. One may, of course, enclose a tuning fork in an exhausted vessel, and, by thus reducing the air resistance to a minimum, obtain better resonant action. Still, the difference would not be very great. But it would make a great difference if the tuning fork were immersed in mercury. In the electrical vibration it is of enormous importance to arrange the conditions so that the vibration is effected with the greatest freedom. The magnitude of the resonance effect depends, under otherwise equal conditions, on the quantity of electricity set in motion, or on the strength of the current driven through the circuit. But the circuit opposes the passage of the currents by reason of its impedance, and, therefore, to secure the best action it is necessary to reduce the impedance to a minimum. It is impossible to overcome it entirely, but merely in part, for ohmic resistance cannot be overcome. But when the frequency of the impulses is very great, the flow of the current is practically determined by self-induction. Now, self-induction can be overcome by combining it with capacity. If the relation between these is such that at the frequency used they annul each other, that is, have such values as to satisfy the condition of resonance, and the greatest quantity of electricity is made to flow through the external circuit, then the best result is obtained. It is simpler and safer to join the condenser in series with the self-induction. It is clear that in such combinations there will be, for a given frequency, and considering only the fundamental vibration, values which will give the best result with the condenser in shunt to the self-induction coil; of course, more such values than with the condenser in series. But practical conditions determine the selection. In the latter case, in performing the experiments one may take a small self-induction and a large capacity, or a small capacity and a large self-induction, but the latter is preferable, because it is inconvenient to adjust a large capacity by small steps. By taking a coil with a very large self-induction the critical capacity is reduced to a very small value, and the capacity of the coil itself may be sufficient. It is easy, especially by observing certain artifices, to wind a coil through which the impedance will be reduced to the value of the ohmic resistance only, and for any coil there is, of course, a frequency at which the maximum current will be made to pass through the coil. The observation of the relation between self-induction, capacity, and frequency is becoming important in the operation of alternate current apparatus, such as transformers or motors, because by a judicious determination of the elements the employment of an expensive condenser becomes unnecessary. Thus it is possible to pass through the coils of an alternating current motor under the normal working conditions the required current with a low E.M.F., and do away entirely with the false current, and the larger the motor the easier such a plan becomes practicable; but it is necessary for this to employ currents of very high potential or high frequency.

In fig. 20 I is shown a plan which has been followed in the study of the resonance effects by means of a high frequency alternator. C is a coil of many turns, which is divided in small separate sections for the purposes of adjustment. The final adjustment was made sometimes with a few thin iron wires (though this is not always advisable) or with a closed secondary. The coil, C, is connected with one of its ends to the line, L, from the alternator, G, and with the other end to one of the plates, c, of a condenser, c, c_1, the plate (c_1) of the latter being connected to a much larger plate, P_1. In this manner both capacity and self-induction were adjusted to suit the dynamo frequency.

As regards the rise of potential through resonant action, of course, theoretically, it may amount to anything, since it depends on self-induction and resistance, and since these may have any value. But in practice one is limited in the selection of these values, and besides these, there are other limiting causes. One may start with, say, 1,000 volts, and raise the E.M.F. to 50 times that value, but one cannot start with 100,000 and raise it to 10 times that value, because of the losses in the media, which are great, especially if the frequency is high. It should be possible to start with, for instance, 2 volts from a high or low frequency circuit of a dynamo, and raise the E.M.F. to many hundred times that value. Thus coils of the proper dimensions might be connected each with only one of its ends to the mains from a machine of low E.M.F., and though the circuit of the machine would not be closed in the ordinary acceptance of the term, yet the machine might be burned out if a proper resonance effect would be obtained. I have not been able to produce, nor have I observed with currents from the dynamo machine, such great rises of potential. It is possible, if not probable, that with currents obtained from apparatus containing iron the disturbing influence of the latter is the cause that these theoretical possibilities cannot be realised. But if such is the case, I attribute it solely to the hysteresis and Foucault

current losses in the core. Generally it was necessary to transform upward, when the E.M.F. was very low, and usually an ordinary form of induction coil was employed, but sometimes the arrangement illustrated in fig. 20II, has been found to be convenient. In this case a coil, C, is made in a great many sections, a few of these being used as the primary. In this manner both primary and secondary are adjustable. One end of the coil is connected to the line, L_1, from the alternator, and the other line, L_2, is connected to the intermediate point of the coil. Such a coil with adjustable primary and secondary will be found also convenient in experiments with the disruptive discharge. When true resonance is obtained the top of the wave must, of course, be on the free end of the coil as, for instance, at the terminal of the phosphorescence bulb, B. This is easily recognised by observing the potential of a point on the wire, w, nearer to the coil.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

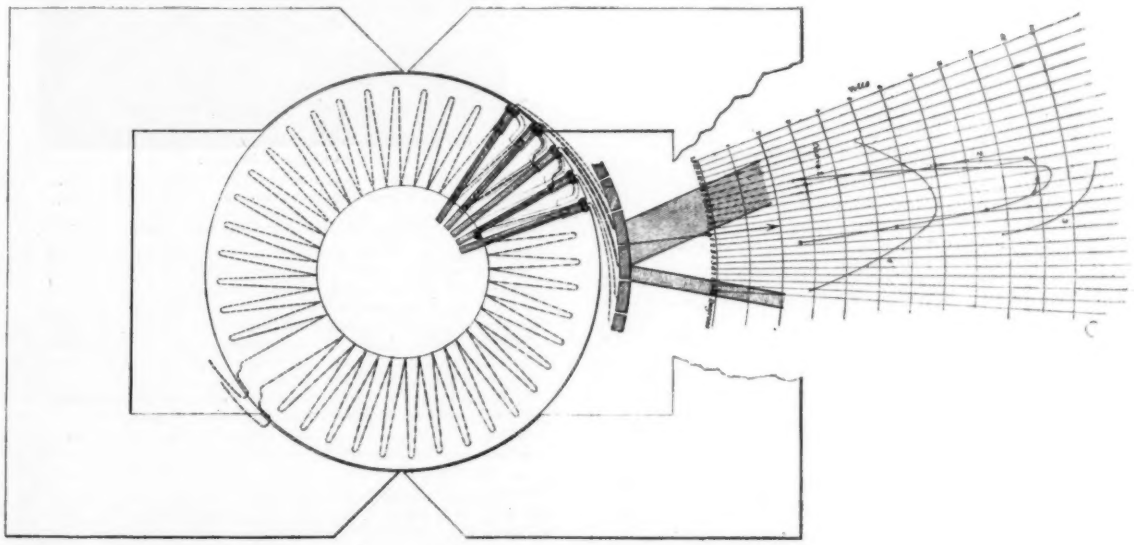
Institution of Electrical Engineers.

ON THE PREVENTION AND CONTROL OF SPARKING; CONTINUOUS-CURRENT DYNAMOS WITHOUT WINDING ON THE FIELD MAGNETS, AND CONSTANT-PRESSURE DYNAMOS WITHOUT SERIES WINDING. By W. B. SAYERS, Associate. Paper read May 11th, 1893.

(Concluded from page 26.)

Proceeding now to consider practical applications of my device, fig. 9 represents diagrammatically the first machine made self-exciting by means of the armature winding alone. The machine is now running at the Bradford Station Hotel, Midland Railway, as a regulator. It is coupled direct to a shunt motor, and driven at constant speed.

Fig 9.
Diagrammatic representation of Dynamo without winding on Magnets.
W. B Sayers



The main current to the hotel is passed through the armature, causing an induction proportional to itself, and thus raising the pressure in proportion to the current flowing, and compensating for the drop in the leads, just as a series machine would do under the same conditions.

Particulars and dimensions of the machine are as follows:—

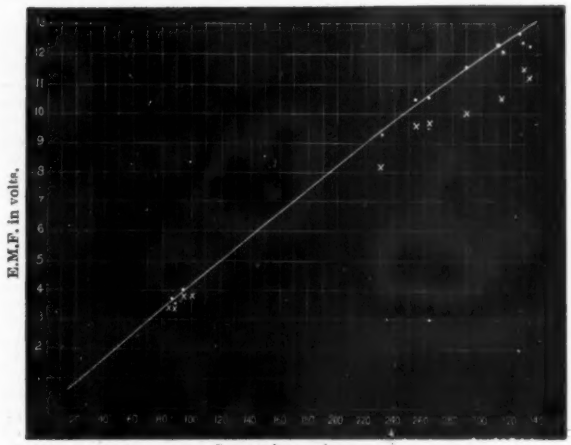
Armature—Ring form.

Diameter, external	9⅝	inches.
„ internal	4¼	„
Length	9	„

The periphery has 40 slots cut into it, in which the conductors are placed. The slots are ⅜ inch deep, ¼ inch wide, and each has two grooves cut in it opposite to each other, near the top. The main winding conductor is of copper strip, 0·15 × 0·5 inch, and occupies the space in the slot below the grooves. The commutator coils or bars are of copper, 0·1 × 0·3 inch, with rounded edges, insulated D.C.C., then double-lap tape. They are slid into the slot from one end, their edges fitting into the two grooves. Thus they serve to hold the conductors in position, and so obviate the necessity for binding. The air space is 1 millimetre.

The keepers (they really are not field magnets) are of double L shape, and made up of charcoal iron plates to prevent heating from the variation of the flux over the polar surface caused by the slots in the armature. The keepers are separated in the centre in order to reduce the cross induction, which is of course very considerable.

I have had in mind trying Prof. S. P. Thompson's suggestion of making the keepers (F.Ms.) up of separate plates, with the object of reducing cross induction. In subsequent machines the necessity for laminating the polar surfaces has been obviated by putting the conductors into tunnels, and only running a saw-drift through the crown of the tunnel to break the iron circuit and reduce the self-induction of the section; the well known device of winding over with charcoal iron wire has also been used.



X Actual readings. ● Calculated points for constant speed of 1,000 revolutions per minute.

FIG. 10.—CHARACTERISTIC OF SELF-EXCITING DYNAMO WITHOUT WINDING ON MAGNETS.

On testing the machine illustrated in fig. 9, it was found, as I expected, to be self-excited, and it will carry a current of 400 ampères at 14 volts running at 900 revolutions per minute. It is capable of running with this current absolutely without spark at the brushes. There is hardly any external field—sufficient, of course, to move a compass, but hardly enough to feel with a piece of iron—except between the two keepers in the space marked F, where there was considerable field, due, of course, to cross induction.

According to Mr. Esson's formula, the output should be $(20·5)^2 \times 9 \times 22·5 \times 15 \times 0·048 = 7{,}000$ watts. The comparatively small output obtained—5,600 watts—is accounted for by the fact that for the purpose for which it was designed (to act as a regulator) it was necessary to keep the induction density in the iron below 10,000 in order that the E.M.F. should be as nearly as possible proportional to the current.

Fig. 10 is the characteristic curve of the machine—the horizontal distances representing the current, the vertical distances the volts.

The most remarkable feature observed about the machine when self-exciting is its extreme sensitiveness with regard to the position of the brushes, a very small movement causing a great variation in the volts. Moreover, it will not excite at all unless the brushes are within a certain arc of about 9°; the position of this arc corresponding with the position in which the hindermost commutator bar under the brush is under the pole-tip, and the foremost one has passed out from under it.

The curves to the right of the brush in fig. 9 represent the volts observed with the brushes in various positions. The pointer drawn through the brush indicates the point in the curve corresponding with the brushes in the position shown. Thus, if the brush and pointer were shifted in either direction, the pointer would indicate the volts corresponding with the position of the brush.

Curve No. 1 is plotted from results obtained when the machine was running at a speed of 850 revolutions per minute, and an external resistance in circuit of about 0·03 ohm, the maximum current reached being about 340 ampères. For curve 2 the speed was 1,000 revolutions per minute; external resistance, 0·038 ohm; and maximum current, 291 ampères. Curve 3 shows the effect of one turn of series winding around each keeper, with speed 1,000; external resistance, 0·0455 ohm; current, 202—265 ampères. Curve 4 shows the effect of moving the brushes when a constant current is passed through the armature: speed, 1,000; current, 200 ampères. These curves are plotted from the Tables I., II., III., IV., given below.

It will at once be obvious to all that a shunt machine with armature on my principle may be made to keep pressure constant with varying current, part of the armature winding performing the function hitherto performed by the use of series coils on the magnets. As would be expected, the armature coils so used are several times more effective, turn for turn, than an equal number of series coils upon the magnets. First, they count double, because they would exist as *back* turns if the machines were running with a forward lead; and, second, because, whereas in the latter case the effect of the series coils—or, rather, of the remainder of them after subtracting the number of the back turns—depends upon the permeability of the field magnets and armature, and all magnetic leakage is of course ineffective, the action of the forward turns on the armature when running with a backward lead, though depending on permeability of the armature core and magnets, is wholly effective, even the leakage (if we so call the lines which do not pass around the magnet cores) being necessarily cut by the conductors on the armature.

Particulars of such a machine are as follows:—

PARTICULARS OF 9-UNIT SHUNT-WOUND DYNAMO, 100 VOLTS, AT 920 REVS. PER MINUTE.

Armature—

Diameter at bottom of slots, $6\frac{7}{8}$ inches.
" of hole in centre of discs, 2 inches.
" over all, 9 inches.
Length of iron core, 10 inches.
Dimensions of slots, $1\frac{1}{16}$ inch deep by $\frac{1}{4}$ inch wide.
Number of slots, 40.
Total turns of main conductor on armature, 80.
Turns per section of armature, 2.
Commutator Coils: Turns to each section of armature, 1.
Sectional area of main armature conductor, 0·180 × 0·160 = 0·0288 square inch.
Sectional area of commutator coils, 0·180 × 0·08 = 0·0144 square inch.
Resistance of main conductor between points of connection to commutator coils at T = 100° Fah., 0·025 ohm.
Resistance of two commutator coils in series, being the maximum resistance added by these coils to armature at T = 100° Fah. = 0·005 ohm.
Total resistance of armature, 0·03 ohm.

Weight of main armature conductor	... ...	35·4 lbs.
" of commutator coils	... ...	8·8 "
Total weight of armature conductor	... ...	44·2 lbs.

Commutator coils one section in rear when running as generator of armature sections to which they are connected.

Field Magnets:—

Cores of scrap iron, 6 inches thick by 10 inches broad. Cast 3 inches into sole plate at lower ends. Sole plate therefore acts as yoke, and has approximately double the sectional area of cores.
Bore of pole-pieces, $9\frac{7}{8}$ inches.
Angle subtended by polar face, 130°.
Length of wound portion of magnet cores, 8 inches.
Winding, 120 lbs. No. 18 S.W.G. (0·048 inch diameter).
Resistance, 70 ohms.
Total turns, about 5,120.
Ampère-turns in shunt winding, 7,300.
Current through shunt coils, 1·43 ampères.

From the foregoing we get the following in C.G.S. units:—

Armature:—

Effective area of core, allowing for 5 per cent. occupied by paper, 297 sq. cms.
Total induction through armature core, 4,000,000.
Density, I = 13,400.

Field Magnets:—

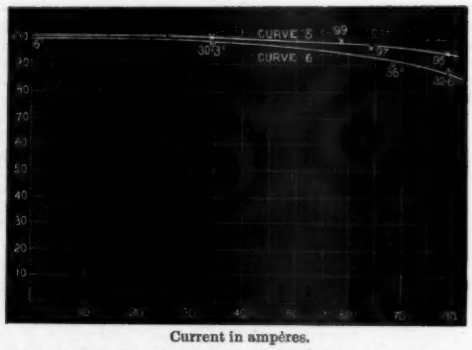
Total induction through magnets, assuming leakage coefficient of 1·2, = 4,800,000.
Density, wrought iron, I = 12,400.
" cast iron, I = 6,200.
" air space, about I = 6,700.

Magnetising force required:

Air space (2 l. = approx. 1 cm.) =		5,350 ampère-turns.
Armature core	... ...	320 "
Magnet cores	... ...	828 "
" yoke	... ...	642 "
Total	... ...	7,140 "

This machine was not originally designed to be self-regulating when running with a backward lead, and consequently the width between the magnet cores only allows of an angular breadth embracing $2\frac{1}{2}$ to 3 sections of the armature to assist the forward induction. In fig. 10, curves 1 and 2 show the performance of the machine as a generator when run with backward and forward lead. With backward lead the position of the brushes remains unchanged with all loads. The E.M.F. on open circuit is 100·5 volts at 920 revolutions per minute, at full load 95 volts. Thus, allowing 3 volts for drop in armature and brush connections, the E.M.F. generated at constant speed of 920 revolutions per minute is 2·5 volts less with full load than on open circuit. With forward lead the E.M.F. is 100 volts on open circuit at a speed of 980 revolutions per minute, and 88·8 volts at full load. Allowing 3 volts for drop, as before, the E.M.F. generated is 8·2 volts less with full load than on open circuit, and the brushes require shifting through a total angle of about 35° between no load and full load.

Tables V. and VI. give the readings from which the curves 5 and 6, fig. 11, are plotted. In the experiment the E.M.F. was kept as near as possible constant, the results with constant speed being calculated therefrom. Run with a forward lead the machine displays the drop inevitable with a rather short air space.



CURVE 5.—Backward constant lead 920 revolutions per minute.
CURVE 6.—Forward increasing lead 980 revolutions per minute.

FIG. 11.—MACHINE No. 308, Test made March 6th, 1893.

TABLE I.

Speed.	E.M.F.	Current.	Position of brushes.*	Remarks.
1,019	11·2	291	− 2°	Slight sparking.
1,000	8·35	217	+ 0·8°	Sparkless.
1,055	4·68	175	− 4°	"
1,062	2·83	78·14	− 6°	"

* The zero position of brushes is indicated in the diagram, fig. 9. The sign + in front of the figures indicates that the brushes were in front of the zero position; the sign − that they were behind the zero position.

TABLE II.

All Results are Means of Three Readings.

Speed.	E.M.F.	Current.	Position of brushes.	Remarks.
847	5·6	189	+ 1·8°	Sparkless.
850	8·35	289	+ 0·8°	"
850	9·9	321	− 0·4°	Slight sparking.
850	10	340	− 1·3°	" "
850	9·76	326	− 3·2°	Sparking.
850	7·1	237	− 4°	...

TABLE III.

Speed.	E.M.F.	Current.	Position of brushes.	Remarks.
1,016	12·1	265	− 2°	Sparkless.
1,032	9·2	202	+ 3·2°	"

TABLE IV.

Means of Three Readings.

Speed.	E.M.F.	Current.	Position of brushes.	Remarks.
991	6·1	200	+ 2·3°	Sparkless.
996	5·66	199	+ 4°	Slight sparking.
1,005	4·6	199	+ 5·8°	More sparking.
1,013	2·92	194	+ 9°	Slight sparking.
984	6·7	204	+ 0·8°	Sparkless.
991	6·78	207	− 2°	Slight sparking.
994	6·1	206	− 5°	More sparking.
1,002	5·21	204	− 7·5°	Sparking under brushes.
988	4·86	205	− 9°	Slightly more.

TABLE V.

Speed.	E.M.F.	Current.	Brush displacement relative to position at no load.
918	101	0	0
920	100	0	...
928	101	34	...
942	103	35	...
906	100	58	...
916	100	58	...
940	100	67	...
966	101	62	..
964	100	80	...
964	99	78	...

TABLE VI.

Speed.	E.M.F.	Current.	Brush displacement relative to position with backward lead.
978	97	0	6·6°
940	98	0	6·6°
1,002	100	35	30·3°
990	102	34	30·3°
1,120	100	72	36·0°
1,120	108	65	36·0°
1,078	98	78	32·6°
1,116	100	79	32·6°

I think I am perhaps entitled to say that all the machines I have made have been made to fill orders, which they have successfully done. So far, my experience has been that the shorter the air space the better as regards sparking and fixity of the collecting position. If solid magnet cores are used, as they must usually be on account of the expense of laminated cores, the length of the air space is limited by the width of the slots. In this connection I have found that the slots may be 1·5 times the length of air space without any appreciable heating of the poles or waste of power from eddy-current in them. If the armature is wound over with iron wire of sufficient thickness compared with width of slot, or if the conductors are in tunnels, the length of the air space can be fixed having regard to mechanical considerations only. In this connection, however, it is necessary to take into consideration the unequal pull of the keepers, or magnets, if the armature is a little out of centre; for, unless the shaft is very stiff, this may be sufficient to cause the armature to touch against the keeper when excited.

My machines, made by Messrs. Mavor & Coulson, of Glasgow, of course, run with a forward lead as motors, the forward armature turns still increasing the induction.

I have perhaps hardly laid sufficient emphasis upon the fact that increase in the armature current increases the strength of the flux-horn, and so tends to automatically bring about the sparkless reversal of the sections without any shifting of the brushes.

I think it will be abundantly clear that, so far from having fully described what may be done by means of my device for bringing the commutation of ring and drum armatures under independent control, I have only touched on the border of a new field of design for continuous-current machines.

NEW PATENTS—1893.

12,490. "Improvements in the means of conveying or administering electricity for medical purposes or others." E. S. D'ODIARDI and E. S. D'ODIARDI. Dated June 26th.

12,491. "Improvements for admistering electricity to animals or human beings." E. S. D'ODIARDI and E. S. D'ODIARDI. Dated June 26th.

12,492. "Improvements in liquid electrodes." E. S. D'ODIARDI and E. S. D'ODIARDI. Dated June 26th.

12,493. "Improvements for charging vapours for inhaling purposes or others with electricity." E. S. D'ODIARDI and E. S. D'ODIARDI Dated June 26th.

12,507. "Improvements in the construction of galvanic cells.' C. VOGT. Dated June 26th.

12,514. "Improvements in safety fenders or life guards for electric street railway carriages and other vehicles." E. ROCHESTER. Dated June 26th. (*Complete.*)

12,516. "An improved loud-speaking telephone and circuits for same." A. GRAHAM. Dated June 26th.

12,523. "Improvements in or connected with brushes or other appliances for the curative application of electricity." C. J. WOLLASTON. Dated June 26th.

12,577. "Underground electric system." J. A. K. MCGREGOR. Dated July 27th. (*Complete.*)

12,612. "Improvements in the construction of electric fittings." E. PRIDDLE, NEWINGTON PRIDDLE & Co., LIMITED. Dated June 27th.

12,625. "Improvements in and connected with the purification of sewage by electrolysis, producing electricity as a bye-product." W. WALKER. Dated June 27th. (*Complete.*)

12,662. "Improvements in electrolysis." E. ANDREOLI. Dated June 28th. (*Complete.*)

12,700. "An improved electric push or contact maker." R. BEVERIDGE. Dated June 28th.

12,785. "Improvements in switches for electric currents." A. G. NEW and A. J. MAYNE. Dated June 29th.

12,786. "Improvements in self-regulating mechanisms for electric arc lamps." A. G. NEW and A. J. MAYNE. Dated June 29th.

12,787. "Improvements in the manufacture of coke or carbon for electrical purposes." J. L. DOBELL, C. P. SHREWSBURY, F. L. MARSHALL and J. COOPER. Dated June 29th.

12,806. "Improvements in electrical switches." F. A. THUM. Dated June 30th. (*Complete.*)

12,850. "A counter of electricity." F. A. BROCQ. Dated June 30th.

12,852. "Improvements in or relating to the distribution and supply of energy in electric current circuits." W. LOWRIE. Dated June 30th.

12,857. "Improvements in and connected with tanks for the electrical decomposition of chloride of sodium or potassium in solution." J. C. RICHARDSON. Dated June 30th.

12,864. "Improvements in electric locomotives and vehicles." J. F. W. FEATHERSTONHAUGH. Dated June 30th.

12,866. "An improved electric lighter." R. W. BARKER. (Communicated by M. Sommer and B. Troop, United States.) Dated June 30th.

12,872. "Improvements in mechanism for electrically operating clocks." J. PERRY. Dated June 30th.

12,919. "Electrical arc lamps." W. JEFFREY. Dated July 1st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

177. "Improvements in electric drop lights." G. E. PAINTER. Dated January 5th. Relates to improvements in the construction of electric drop lights, and refers particularly to the class in which the lamp is suspended by a current-conveying cord wound upon a drum, by the action of a spring or other counterbalance, and unwound by hand. An automatic locking and releasing device, similar to the well-known form used upon curtain rollers, is employed to give the necessary vertical adjustability. 8 claims.

785. "Improvements in regulating sockets or fixtures for incandescent electric lamps and other translating devices, and in methods of regulating or controlling the flow of current to such lamps and other devices." E. E. RIES. Dated July 6th, 1891. (Under International Convention.) Consists, broadly, in providing a lamp socket or fixture with a self-induction or reaction coil of suitable construction, of compact and efficient form, and so combined with the operating mechanism of said socket or fixture, as to permit the consumer to turn on the lamp and gradually or successively increase the current flowing to the same until it reaches the desired candle-power, and *vice versâ*.

1,313. "Improvements in electric motor cars." S. H. SHORT. Dated January 22nd. Relates more particularly to the propelling mechanism of such cars, and has for its object the simplification of such mechanism and its efficient operation, without the intervention of gearing for coupling the propelling motor with the driving axle or axles of the car. 8 claims.

1,557. "Improvements in electro-magnetic apparatus for producing a reciprocating motion, and in apparatus for supplying intermittent electric currents for that purpose." R. THRELFALL. Dated January 26th. Consists in an improved form of electric motor, in which the electric current is used to produce a reciprocating or backward and forward motion directly, instead of first producing a rotary motion, and the same being afterwards converted into a reciprocating motion by means of cranks or other mechanical appliances. 5 claims.

2,016. "An improved block for use in forming conduits for electrical or other cables or wires, and for analogous purposes." J. PRICE

jun. Dated February 2nd. The object of the invention is to provide a conveniently shaped block having and running horizontally within it one or more channels or tubes of any desirable sectional shape and area, each of such channels or tubes being provided with a specially formed spigot at one end and socket at the other end so that a continuous and watertight conduit for the conveyance of electrical wires, lines or the like may be formed by the use of such blocks when properly joined together and secured. 1 claim.

2,026. "Improvements in electric telephones." H. H. LAKE. (Communicated from abroad by E. A. Grissinger and T. Grissinger, of America.) Dated February 2nd. Has chiefly for its object to provide a receiver wherein the vibrations of the metallic disc, or diaphragm produced by the variations in intensity of the magnetisations of the permanent magnet, shall produce sound-waves which traverse the receiver in parallelism with its axis and are constantly amplified as they approach the ear, thereby causing an increase in intensity and a marked improvement in the distinctness of the reproduced vibrations. The invention also has for its purpose the provision of certain novel features in the construction of the permanent magnet, whereby molecular vibration is largely increased and concentrated, together with other improvements in construction and arrangement of parts. 12 claims.

2,225. "Improvements in the method of purifying electrolytes containing zinc, relating to or connected with the electro-metallurgic production of zinc." G. NAHNSEN. Dated February 5th. When rough zinc or alloys of zinc have to be refined by using the same in the bath as anodes, the lyes taken from the baths, which lyes are always neutral or slightly basic owing to the formation of basic salts, are treated with zinc powder in one vat or more, in order to remove the impurities contained in the said lyes. The latter are employed again for the baths only after having undergone this treatment. The lyes having passed through the baths and taken in solution a small portion of the noxious metals admixed to the rough zinc, are brought again into the vats containing zinc powder in order to be purified anew, and thus alternately made to remove a portion of the alien metals from the rough zinc, and to be freed of these impurities by the zinc powder. 1 claim.

2,290. "Method or process of electric riveting." E. E. RIES. Dated February 5th. Has reference to a novel process of riveting in which the rivets are ordinarily inserted into the holes in a cold state, and then heated to incandescence by the passage of an electric current through the same, and are maintained in that incandescent condition during the operation of heading, whereby the riveting process is greatly facilitated and is accomplished with greater perfection than by the processes heretofore employed for this purpose. 10 claims.

2,330. "Improvements in electric switches." E. A. GIMINGHAM. Dated February 6th. Relates to a simple construction of electric switch, to be worked by the hand applied to a button or handle. 1 claim.

2,412. "Improvements in automatic disconnectors for overhead conductors." A. L. JOHNSTON. Dated February 8th. The object of the invention is (on the breaking of the wire) to automatically cut out the current, so that the wire in its contact with anything or anyone, will be incapable of injury, but can be immediately seized and put out of the way, without exposing the person so employed to danger. 5 claims.

2,448. "Improvements in and connected with the arrangement and operation of relays in telegraphic systems." W. F. WENTZ. Dated February 9th. Consists in special mechanism located at the terminal stations, the function of which is, at and during the opening of a key, to reduce the current of the battery so that the quantity of current which will flow over the line in case there is a leak, will be reduced to such an amount that the leaking current will not prevent the relays in that part of the circuit between the battery and the leak from responding. The mechanism also, is such that when the key closes, the full current of the battery is presented to the line and all relays must respond. 9 claims.

2,488. "Electric lighting system and apparatus therefor." S. L. TRIPPE. Dated February 9th. Consists, first, in the combination with a dynamo-electric machine or other source of constant electric supply, and a series of electric circuits for the supply of lamps, of a switch transformer located between such dynamo or other source of energy and the working circuits, and an electro-magnet interposed between such switch transformer and the lamps; second, in the peculiar construction of the switch transformer whereby it is self-ventilating and adapted not only to serve as a switch, but to also act as a secondary coil in connection with the electro-magnet; third, in the appliances used in preventing sparking and the development of heat at the break of the current on the switch transformer, and fourth, in various other constructions and combinations of parts. 7 claims.

2,497. "Improvements in magneto-electric machines." J. HUNT. Dated February 9th. The improved machine is constructed to be operated by pulling upwardly on a handle. In order to steady the machine it is provided with projecting flanges or foot rests, on which the operator may place his feet, so that by his weight he holds the machine down firmly in place, while he is enabled to exert his strength to the best advantage in pulling upwardly on the handle. By this upward pull the armature of the magneto machine is revolved through suitable intervening mechanism, thereby highly energising the field magnet and sending out a suitable current over the line. 8 claims.

2,724. "Improvements in electro-therapeutical apparatus." A. GRIMM. Dated February 11th. Claim:—An electro-therapeutical apparatus for electrisation by a continuous current of feeble intensity, the said apparatus being characterised by a battery fastened to the body by means of a belt, and having one of its terminals connected to a cylindrical or conical electrode, its other pole being connected to a plate-shaped electrode.

2,744. "Improvements in telephonic instruments." B. HOFFMANN. Dated February 12th. The transmitter is contained in a metallic box within which the receiver is capable of being placed when not in use, arrangements being provided whereby the presence of the receiver in the transmitter box closes the calling-up circuit, which is open when the receiver is absent. The same means are employed for closing the local battery circuit through the transmitter when the receiver is removed from the transmitter casing, and for putting the local bell to line when the receiver is replaced. 2 claims.

3,542. "Improvements in telephonic apparatus." H. H. LAKE, (Communicated from abroad by W. Gray, of America.) Dated February 23rd. Consists in the combination of the tubular coin channel and the bell or equivalent sounding device with a part projecting into the coin channel more or less in the path of movement of a falling coin; and it further consists in details of the several parts making up the apparatus as a whole and in their combination. 9 claims.

3,971. "Improvements in power-transmitting devices, especially applicable to the electrical propulsion of vehicles." B. J. B. MILLS. (Communicated from E. H. Johnson, of New York City.) Dated March 1st. Relates to an arrangement of gearing for electrically propelled vehicles in which the motor is connected with the running gear of the vehicle through a frictional connecting device whose frictional engagement is fixed. 4 claims.

3,996. "Improvements in galvanic electric adhesive plasters." W. P. THOMPSON. (Communicated by J. W. Shults, of America.) Dated March 1st. Consists of cells incorporated in the plaster compound of potential arrangement; the elements of said cells being, when the plaster is applied to a person, in contact with the body; and of electrodes connected by means of flexible conductors, with the plaster cells, and provided with adhesive supporters adapting them to be held in contact with the body at such places as may be desired. 5 claims.

4,010. "Improvements in telephonic apparatus." W. C. LOCKWOOD. Dated March 1st. Relates to certain improvements upon the invention for which Letters Patent of the United States were granted to the inventor on July 27th, 1886, No. 346,377 for improvements in telephones, and which had for its object to provide for passing a powerful current, capable of overcoming a great resistance, through the main line of telephone system by the inductive magnetic action of the cores of a series of spools embraced in a local battery and transmitter circuit upon the core of an independent spool embraced in the main or receiver circuit. 3 claims.

4,244. "Improvements in connection with ships' telegraphs." H. ENDALL. Dated March 3rd. Has for its object to enable the captain of a ship to ascertain as soon as he has given an order as to the direction in which the ship is to be propelled, whether his orders are being faithfully executed by the engineer below or not. 1 claim.

4,617. "Improvements in electrical attachments for pianos." F. A. FELDKAMP, J. SCHOENHAAR, and E. E. LEHR. Dated March 8th. Relates to an attachment intended for use in connection with pianos controlled by an electric current and a contact making and breaking apparatus used in connection with a perforated sheet of paper, whereby, by means of these several devices and the electrical system, a piano can be made to reproduce automatically any piece or composition, in exact accordance with the intentions of the composer, not only as to rhythm and melody, but also as to expression, as each and every single note can be played either in its normal strength, "piano," "forte," or "fortissimo," as marked by the composer, and the "crescendo" and decrescendo" can be exactly reproduced. 9 claims.

5,634. "Improvements in electrically controlled elevators and switch mechanism for use therewith." J. Y. JOHNSON. (Communicated from abroad by N. Hiss of Baltimore.) Dated March 22nd. Comprises a series of parallel or branch circuits, one for each floor, and electrically operated devices so constructed that when one of the switches or push buttons is actuated the car will move to and come to rest at that floor, no matter whether the car be above or below the floor. 13 claims.

6,050. "Improvements in insulated electric conductors." W. P. THOMPSON. (A communication by J. B. Williams, of California.) Dated March 29th. Consists, primarily, in interposing, between the insulating layer or dielectric and the conductor, air spaces preferably made continuous, together with certain intermediate and supplementary aids to insulation, whereby the efficiency of the insulation is materially increased. 9 claims.

6,083. "Improvements in incandescent electric lamps." F. S. SMITH. Dated March 29th. An iron wire of the proper size is first carefully cleaned and brightened by polishing with emery paper, or in any other convenient manner. Two wires, or the arms of a single piece of wire bent upon itself, are then held in their proper relative positions for forming the stem. A small quantity of glass is then fused upon the wires, fixing them in position. By afterwards applying a suitable cement or plastic substance at the point where the wires enter the glass, a perfectly air-tight seal is obtained. The sealing compound may consist of a mixture of the yellow oxide of lead, one part by weight the red oxide of lead, two parts, and the carbonate of lead about five parts, all thoroughly mixed, and ground with boiled linseed oil sufficient to form a thick paste. 2 claims.

9,815. "Foot supports for telegraph and other poles and masts." E. A. STREETER. (Under International Convention.) Dated December 7th, 1891. Is intended to provide an improved foot-support for use in climbing telegraph and other poles and masts, and to insure in such a support greater stability and security, and a broader and firmer tread for the foot, than are afforded by the spikes or rounds now used for such purposes. 3 claims.